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An Aseptic Root-Canal Technic—*Coolidge*

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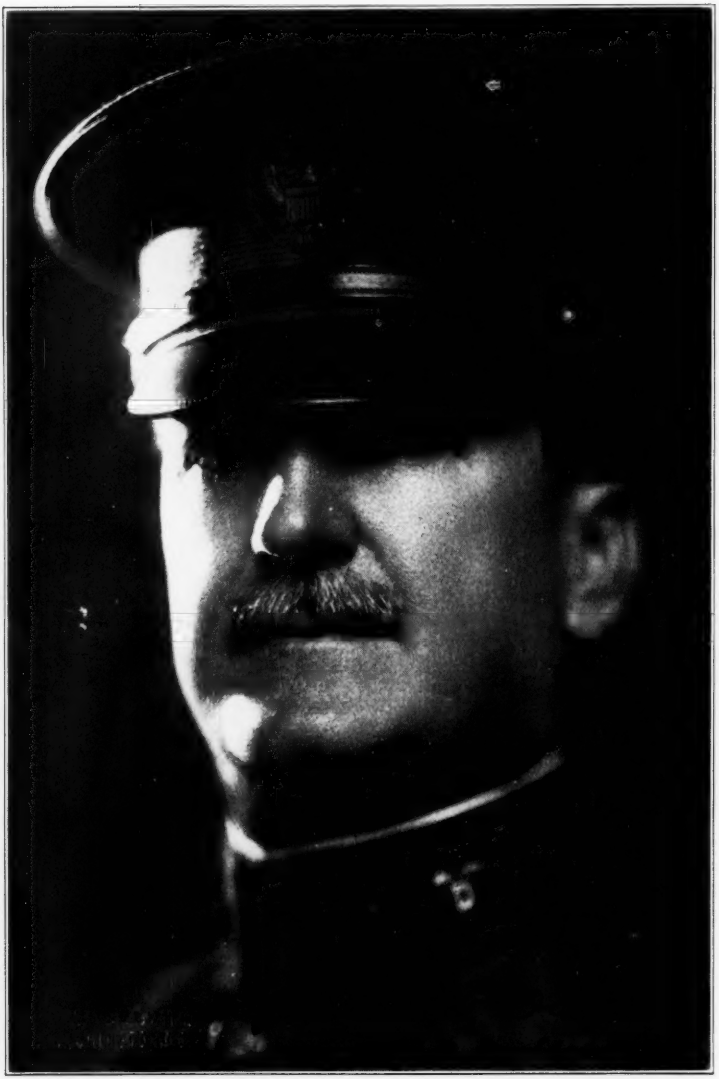

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Vice-President, National Dental Association

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Original Communications

CHRONIC SYSTEMIC INFECTIONS AND THEIR SOURCES

By ERNEST E. IRONS, M.D., Chicago, Illinois

(Read before the Chicago Dental Society, January 27-29, 1921)

YOU have honored me with an invitation to bring before you the much discussed relation of lesions associated with the teeth to systemic disease, a subject which bears an intimate relation to the work of the dentist and the physician. I must confess to a certain diffidence in attempting to present a topic even partly dental to an association which includes in its membership the many distinguished dental surgeons whose contributions have done so much to advance our knowledge of diseases of the mouth. In extenuation of my temerity in this respect I can only plead that in the dental creed here expressed I have attempted to adhere to their teachings.

The interest of the medical profession in dental problems and in the relation of lesions of the mouth to general disease is not confined to this modern era. Jean Louis Petit, surgeon of Paris (1674-1760), relates his experience with dental infection and sytemic disease in the *Traité des Maladies Chirurgicales.* After enumerating the symptoms, including cough, loss of appetite, difficulty in obtaining sleep, chills and fever, from which one of his patients suffered, he continues: "The physicians whom he had consulted were led to believe that he was affected with consumption, and they treated him with this belief, but so far without success. On examination I found that two of his teeth were carious and I advised their extraction. A rapid restoration of the patient's health followed in less than a fortnight."[1] I would invite your attention to the procedure of our ancient surgeon. He does not say that he extracted the teeth, as he might well have

[1]Buck, *The Dawn of Modern Medicine*, 1920.

done at that time, but that he advised their extraction, and no doubt he secured such dental consultation as may have been available in those days. We have in recent years passed thru a period when both dentists and physicians have failed to avail themselves of the advice of their colleagues, but happily, I believe, that day is rapidly closing, and we are entering an era in which co-operation between the two professions will be close and cordial.

The increase of knowledge regarding the relation of acute and chronic local infections to more widespread and often disabling disease has made possible the prevention of much suffering and has been the means of restoring to health many of those who seemed in previous years to be condemned to recurrent disability and even permanent invalidism. The dental profession has contributed largely to this end by introducing methods for the recognition and cure of infections about the teeth. While experience teaches that the removal of alveolar abscesses frees certain patients from recurrences of their arthritis or other metastatic lesions, and while it is fairly clear why such a result is often to be anticipated, it is not so evident why many other alveolar abscesses remain symptomless and, so far as can be determined, wholly unassociated with metastatic disease. Why should infections of the alveolar processes behave differently, and what are the influences which lead to metastatic infection from an alveolar abscess which has lain quiescent for months or years? Dental infection in its relation to the body may be best understood when considered with other similar sources of metastatic disease and I propose to discuss some of the more general facts of the mechanism of infection, and later to attempt to apply these conceptions to the solution of the problem of the patient who comes in search of relief. But before passing to the question of metastatic disease, we may consider briefly some of the more general relations between disease of the mouth and that of the remainder of the body.

The Mouth and General Disease

The intimate relation, sometimes causal and sometimes resultant, between disease of the mouth and general disease needs no emphasis. The recurrent glossitis and other oral inflammation of pernicious anemia, the hemorrhages of the gums and mucous membranes in leucemia and scurvy, and the herpes associated with gastric disturbances exemplify the close interrelations of the tissues of the mouth with the rest of the body. The degenerative diseases, including arteriosclerosis and chronic nephritis, appear to depend for their cause in part upon chronic infections derived from the mouth. In a study of the teeth in 329 cases of various diseases in Cook County Hospital of which 124 were radiographed, alveolar abscesses were found in 44 per cent. When these patients were classified according to disease, 76 per cent were found to have alveolar abscesses in the arthritic group, 47 per cent, abscesses in the cardiovascular group, and of the remainder, including acute diseases such as typhoid fever and pneumonia, 23 per cent were found to have abscesses. Other investigators have found a still higher percentage of alveolar abscesses in various groups, and have also emphasized the effect of chronic infection in the production of chronic degenerative diseases. Black found in radiographs of 600 adults that 78 per cent showed areas of bone destruction, but in 72 per cent there were as yet no evidences of systemic disease. More difficult of demonstration, but of apparently none the less importance to the general health, is the direct absorption of infection and the swallowing of pus derived from the infected gums of pyorrhea. The absence of immediate symptoms does not indicate that progressive damage is not occurring, but only that the effects have not become

clinically visible. The unfavorable influence of such prolonged exposure to the products of suppuration will be referred to later, but no argument appears necessary to establish the desirability of the elimination of such chronic infections.

Mechanism of Infection

It is of course well recognized that the sites of chronic infection in the body are many and include teeth, tonsils, sinuses, prostate, gall bladder, to name but a few of the commoner. It is also a matter of general experience that many people have one or more such infections for months or years without suffering from metastatic lesions in joints, eyes, or elsewhere, so far as may be determined from clinical observation. They may be entirely ignorant of the presence of infection in the body. The chief factors which determine whether the infection shall remain confined to its local site or whether it shall extend into adjacent or distant parts of the body may be grouped under three headings: (1) the virulence or invasiveness of the organism, (2) the nature and extent of the infected tissue, and (3) the resistance of the patient.

Bacteria and other disease-producing viruses vary widely in their ability to invade and produce changes in animal tissues, and this variableness of action depends upon a number of conditions among which are the presence or absence of available food supply, suitable oxygen tension, and the degree of protection offered the bacteria against the fluids and cells of the host. One species of animal is naturally resistant or immune to infection by an organism while another species is extremely susceptible. Different individuals of a species may differ widely in their susceptibility to a given infection, and this difference in individuals is frequently observable in man.

We commonly think of a virulent organism as one which, like the streptococcus in erysipelas or cellulitis, is able to invade the tissues rapidly, with resulting edema, pain, and a course of stormy illness. This conception, while correct so far as it goes, is incomplete and should not divert attention from those infections which proceed more slowly, often unnoticed for a time, but in which the progress of invasion of the host by the bacterium is no less sure. Infection of this latter type is illustrated by some of the common forms of tuberculosis. The chronic types of metastatic disease of joints and eyes arising from infections about the teeth and other localized areas thruout the body, in their chronicity and in the relative absence of symptoms of systemic disease, resemble the latter more than the former group, altho all degrees of acuteness of both primary and secondary lesions may be found. The process of invasion consists, however, of a series of short steps rather than of one continuous process.

Changes in growth reactions and in ability to invade the animal body have been observed in bacteria during successive transfers in the culture tube, and it has been assumed that similar changes in invasive power occur during their residence in some localized area in the body. It is possible that such modifications occur, but indisputable proof of these changes is difficult to obtain and instances of variations in the disease-producing power of organisms become relatively insignificant when compared with the remarkable constancy of growth and pathogenic power of most disease-producing bacteria or viruses. While it is true that epidemics of contagious disease vary in severity and in case mortality from season to season and even during the course of a single epidemic, the cultural characteristics and the clinical features of the disease in the typical case do not change in any essential particular. Thus typhoid fever, lobar pneumonia, and epidemic meningitis present the same clinical pictures today as they did twenty or more years ago, and the

bacteria which cause them show the same cultural characteristics.

It thus appears that in our inquiry into the mechanism of metastatic infectious disease we must look rather to the remaining two factors, the site and nature of the infection, and the resistance of the patient.

The Extent and Nature of Chronic Infection

One of the outstanding and puzzling factors which appears at the outset of our survey of chronic localized infections is that while many patients present themselves with evidences of metastatic lesions that evidently have their source in a chronically infected area of tissue, there is a very much larger number of persons who are the subjects of chronic local infections of equal or even greater extent, caused by the same bacteria, who show no evidence of secondary infection in the joints or other organs. At first glance such chronic infections might seem to differ in this respect from the acute infections arising from minor wounds, but a moment's consideration will suffice to show that for one pin prick, abrasion, or cut that is followed by serious local or general infection, there are tens or scores of similar wounds incurred under conditions that render likely the introduction of pathogenic bacteria into the wound which promptly heal without clinical evidence of infection.

Evidently the reactions of the cells and fluids of the rest of the body against the impending bacterial invasion, which we are accustomed to speak of as resistance, determine to a large extent the outcome of a local infection, no matter whether it be acute or chronic. The resistance of the body to invasion is, however, not a constant quantity but rises and falls in consequence of changes in nutrition, of fatigue, exposure to cold, or other favorable or unfavorable influences of environment. The course of an acute infection is at once determined by the virulence of the organism, the extent of the area of implantation, and the resistance of the body at the time of the infection, while in the chronic local infection the infecting bacteria are afforded a safe residence in which they may multiply, and from which they may invade the body at any time, often repeatedly when its resistance is temporarily lowered. Bacteria in a chronic lesion thus have many opportunities to invade the body during periods of depressed resistance or, if the resistance of the body is maintained by a wide margin of safety, they may never be able to effect an invasion sufficient to produce symptoms. The tissues involved in the local chronic infection may be in close connection with healthy tissues or they may be surrounded by a fairly firm wall of granulation and connective tissue, which affords some degree of protection to the adjacent uninfected structures. In any case, however, there is a fairly direct communication between the local lesion and surrounding tissue by means of lymphatics and blood vessels. Even in so isolated a lesion as an alveolar abscess the lymphatics pass out to surrounding bone and subjacent tissues, and, as Noyes has shown, the lymphatics below the jaw can be injected thru the pulp chambers of the teeth of the mandible. The enlarged regional lymph nodes found in association with chronic infections of the mouth and tonsils afford clinical evidence of the close lymphatic connection between infected areas and surrounding tissues.

The degree of confinement of the infected area may influence the passage of organisms thru lymphatics and blood vessels, and, clinically, generalized infections result more often from lesions entirely closed, either acute or chronic, than from those in which external drainage is free.

The defenses of the body against bacteria which have passed the skin or mucous membranes or have entered thru the gateway of chronic localized infec-

tions are maintained by means of the antibacterial action of the fluids of the body, by the action of the leucocytes and other phagocytic cells, or by a combination of these. Several of these reactions can be demonstrated in the test-tube and have received various descriptive names, such as phagocytosis and agglutination. While some estimate can be made in the laboratory by means of the reactions of the probable resistance of the body to impending infection, it is quite possible that the mechanism of bodily defense involves other or more intricate chemical reactions which have thus far eluded demonstration by the physio-chemical means at our command. Nevertheless, we know that the resultant of these forces which we call resistance varies greatly from time to time, in response to change in physical environment, such as exposure to cold, severe local injuries, starvation, errors in diet, fatigue, and with the changes attendant on the passage from youth to old age.

In view of these many circumstances, one of which or several in combination may serve to favor or to prevent the passage of organisms from a chronically infected area into the body, it is not surprising that such lesions may produce metastatic lesions in one person and remain symptomless in another, or that an infection which has remained quiescent and unrecognized for years may suddenly cause widespread and disabling disease.

Resistance to infection or immunity is only relative and the fine balance may be turned unfavorably to the patient by any of the physical agents just enumerated. Immunity which is sufficient to protect against the degree of exposure ordinarily met with may prove ineffective when the dose of infecting organisms is increased. Antityphoid inoculations confer an increased immunity to typhoid fever, and persons so inoculated do not contract typhoid even when they occasionally ingest typhoid bacilli in numbers in which they usually occur in polluted water supplies. However, if these same persons are daily exposed by the ingestion of heavily polluted water as happened to certain companies of soldiers in France in the world-war, they do contract typhoid fever. The danger of presuming too much upon natural immunity is seen in the serious infections, sometimes resulting in general sepsis and death, which occasionally follow the extraction of many infected teeth at one time. The dental axiom that where many infected teeth are to be removed only two or three should be extracted at each sitting at intervals of several days expresses in terms of dental practice the necessity of conserving the resistance of the patient by avoiding an overdose of infection thru the laying open of excessive areas of tissue and lymphatic vessels.

Multiple Infections

Just as an infection involving large areas of tissue is more likely to result seriously for the patient than is one due to the same cause but confined to a small area, so infection of several areas involving different tissues is more difficult to eradicate than is a small single lesion. Illustrations of the unfavorable effect on the patient of one infection superimposed on another, such as in secondary pyogenic infections in pulmonary tuberculosis, are also seen in cases of coincident infections of teeth, tonsils and sinuses. In our study of iritis, Dr. Brown and I frequently found two or more sites of infection, and in a number of such instances the relief of the iritis was correspondingly slower than in those cases in which the infection was more limited.

In considering the possible time relations between infections of teeth, tonsils, eyes, and joints, the teeth have been charged by some with being the primary offenders. In a number of instances it has seemed not unlikely that the primary source was elsewhere, as in the tonsils, and that occasionally the lesions developing about the roots of pulpless but other-

wise presumably healthy teeth were as truly metastatic as was iritis, or arthritis, tho occurring at an earlier date. With this thought in mind it appears not unreasonable for the dentist who is confronted with the problem of keeping in order a mouth in which repeated infections continually add to the difficulty of conservation of the teeth to request a survey of the patient for other sources of infection. The teeth should not be obliged to bear all the odium of primary sin.

Other Portals of Infection

Even a brief review of the mechanism of infection would be incomplete without some reference to certain other perhaps less frequent and undoubtedly less considered routes of ingress of organisms in chronic and recurrent infections. The relation of these routes to the infections which enter by them may perhaps be best understood by reference first to the acute infectious diseases. The walls of the pharynx, trachea, and bronchi are supplied with an extremely rich network of lymphatics, which afford means of transportation for such bacteria and viruses as are able to pass the mucous membrane. Blake and Cecil have shown that lobar pneumonia can be regularly produced in monkeys by the introduction of a minute amount of virulent organisms within the trachea by means of a sterile needle passed thru it just below the larynx. Within three hours after such inoculation, organisms can be demonstrated in the walls of the bronchi, and within six hours can be isolated from the blood.

Within the stomach the free hydrochloric acid of the gastric juice exerts a strong antiseptic action, so that the normal stomach content usually contains few of the commoner organisms, such as streptococci, and thus a large proportion of the pathogenic organisms that pass from the mouth to the stomach are here destroyed. During periods when gastric secretion is suspended or greatly decreased, or when the free hydrochloric acid is neutralized, organisms susceptible to the acid may escape death and pass on to the intestine. That this occurs not infrequently was shown by some investigations of the feces in scarlet fever, a disease in which hemolytic streptococci are found quite regularly in the throat. In 30 per cent of cases Dr. Moody and I were able to demonstrate hemolytic streptococci in the feces, altho in some instances many examinations were required. In typhoid fever it is generally held that the organisms pass from the intestine into the blood stream by way of the lymphatics. Tuberculous lesions of the thoracic duct have been noted in cases of primary intestinal tuberculosis, and other diseases, such as some forms of anthrax and actinomycosis, have been held to have a similar pathogenesis.

Clinically in certain forms of chronic colitis arthritis is met with, and at necropsy in many cases of acute and chronic intestinal infection there is extensive enlargement of the mesenteric lymph nodes.

The number of instances in which the infection which gives rise to an iritis or arthritis, commonly associated with chronic local lesions, enters the body thru the supposedly intact mucous membranes of the pharynx, trachea, or intestine, is, so far as we can now show, relatively small, but a limited group of carefully studied cases suggests that this route must be considered. Were it not that the recognition of this route seems important in understanding certain obscure cases in which the search for the cause of metastatic infection has been heretofore unavailing and in which a further sacrifice of unoffending teeth and other organs impends, an incomplete reference to the gastro-intestinal tract as a source of infection might be regarded as unjustifiable in that it may stimulate rather than check the unscientific use of the term "intestinal autointoxication." Perhaps no term in medicine has been so poorly defined in the minds of medical

men, and no other term has been so overworked and used as a cloak for ignorance, often to the detriment of the patient, as the term "intestinal autointoxication," which substitutes a catchy phrase for a careful examination. It is only after a thoro examination of the more usual sites of chronic infection that a diagnosis of metastatic infection arising from this source should be entertained.

In view of the manifold influences both within and outside of the body, which may play a part in determining the course of an infection, it does not now seem strange that in one patient the bacteria in an alveolar abscess remain localized and in another produce metastatic disease. Infections about the mouth probably stand first in point of frequency as a cause of metastatic infections, but the entire burden of effort for the recovery of the patient should not be arbitrarily thrown upon the dentist in view of the many other sources of infection, some of which have been frequently overlooked. It also sometimes happens that pains, supposed to be infectious in origin, are in reality due to other causes, including nervous disorders and secondary malignant growths.

The Problem of the Patient

In order that the interests of the patient may be best served thru close and well-correlated team play of dentist and physician it is essential that the problems of each be understood by the other. The urgency of the demand for correction of dental disease varies greatly in different patients and is determined by considerations which in one case may be quite different from those in another. It is the failure in the first instance to recognize that such differences exist, and then the difficulties of properly evaluating them that have led to many of the misunderstandings among physicians themselves, and between them and their dental colleagues. I may best make this clear by some hypothetical cases.

A man on routine examination is found to be in fairly good health, or perhaps a little below par in some respects, and he has some teeth with clearly marked or doubtful apical destruction. The correction of such pathological conditions as are present is evidently a dental problem, in which the judgment of the dentist will determine what, if anything, shall be done with these teeth. It is assumed that definite alveolar abscesses will receive appropriate treatment with a view to conserving if possible the masticatory function.

Again, a man suffers from pains in joints or nerves, frequently described by the popular term "rheumatism," and perhaps has minor anatomic changes in the joints. Upon examination it is found that in addition to areas of infection, elsewhere in the body, he has one or more teeth the radiograms of which show apical destruction, such that the dentist cannot be certain whether active infection is present or not. It is obvious that the dental management should be conservative along lines determined by the local conditions in the mouth, and the evident infections elsewhere in the body should be dealt with rather than teeth sacrificed.

Similarly even where secondary manifestations of infection are more serious, as in the more severe forms of arthritis, the removal of teeth about whose roots there are minor lesions, which the well-trained dentist believes to be without active infection, is to be deprecated, especially in view of the resulting interference with mastication and perhaps nutrition upon which the future welfare of the patient so largely depends.

The relative importance of the factors in the following example are decidedly different from those in the foregoing. A man lost the sight of one eye by an accident in childhood. He is now having recurrent attacks of iritis in his remaining eye and vision has been reduced to less than half. Further recurrences must be prevented if he is to escape total blindness. A careful examination

shows no demonstrable infectious lesions except a slightly infected tonsil and two or three teeth concerning the infection of which the best dental consultants are doubtful. In view of the irretrievable loss of sight, which will result from further iritis, radical treatment of both tonsils and teeth seems to be not only justified but demanded.

Between these extremes there occur all manner of combinations of findings and degrees of urgency, and a satisfactory decision can only be arrived at thru close co-operation of the physician and his dental and other colleagues.

The therapeutic results to the patient of the removal of infection will vary greatly in different persons. The secondary lesions may be limited in extent but cause great disability, as in iritis or arthritis of a joint essential to the use of an extremity, or the lesions may be widespread and progressive, but in the early months may cause relatively little disability. Upon the removal of an alveolar abscess or other infection, the metastatic inflammation frequently subsides rapidly, in some instances even more rapidly than seems possible on theoretic grounds; in other cases improvement may be preceded by an exacerbation of the secondary infection, followed by slower but permanent healing. This variability in behavior of the secondary lesions may perhaps be related in the case of the alveolar abscess to the type of the infection, whether partially inclosed by a dense layer of granulation tissue or whether continuous from the dental structures into the alveolar process with lymphatic vessels freely passing to the surrounding tissues.

Where secondary invasion of the joints is widespread improvement may be slow, even when it seems certain that the original site of infection has been removed. It is only fair to state that a number of good clinicians are extremely doubtful whether anything of value is gained by attempts to remove local infections in cases of widespread arthritis, particularly of the type known as arthritis deformans. It is well recognized that periods of spontaneous improvement occur independently of such attempts, that in such cases the joints themselves may become sources of infection for other joints, and that the most important measures are those which will assist in increasing resistance by improving the nutrition of the patient. While these facts are evident to anyone who has studied such cases, I cannot agree with those who take an absolutely pessimistic view of the results to be anticipated from attempts to rid the body of sources of further infection, provided that it is recognized that such measures are only preliminary to patient and perhaps long continued care and general supportive treatment. Even the most thoro treatment based on clinical studies of metabolism and on the removal of chronic infection sometimes fails to stay the course of the more severe types of arthritis deformans.

Some Medico-dental Misconceptions

Ten years ago but few physicians concerned themselves with the difficulties encountered by dentists in the care of the teeth, and most dentists were equally uninformed in regard to changes that occur in the body as a result of diseases of the mouth. The mutual study of problems of disease has been of inestimable advantage to both professions, but with this broadened scope of information there have come certain misconceptions, which have grown largely thru incomplete and partial knowledge of anatomy and physiology in the new fields.

I hesitate to refer to so purely a dental question as that of the "dead tooth." Most physicians, and possibly a few dentists, conceive that a pulpless tooth is a "dead tooth." Since the nutrition of a pulpless tooth may still be maintained by the intact peridental membrane, and its lymphatics may still be in vital connection with the lymphatics of the alveolar process, the use of the term

"dead tooth" in this connection is inaccurate and misleading. Terminology here may be profitably improved, but the essential fact to be insisted upon is that loss of sensory function of the pulp thru its death does not fatally impair the nutrition of the tooth, and evidence adequate to warrant its removal must come from sources other than the demonstration of loss of pulp sensation. It is of course understood that such a tooth is probably more susceptible to infection, and by reason of its decreased sensitiveness requires more careful supervision than normal teeth.

Another misconception is encountered in the attempted application of the results of examination of the white cells of the blood to decisions as to the presence or absence of infection about the roots of teeth and the consequent determination of treatment. Efforts by dentists to study patients more thoroly by means of laboratory examinations, such as blood counts, are most laudable, but unless the dentist is able himself to interpret his reports he is very likely to be misled. It repeatedly happens that the dentist perhaps in doubt as to the presence of apical infection, and desiring to give his patient the best attention possible, sends him to a laboratory, and receives a report that the blood shows a leucocytosis, and that therefore infection of the teeth is still present and is to be sought. Infection about the teeth evokes a reaction in the leucocytes in no wise different from infection in tonsils or in a corn, and the chances of error from the information afforded by a leucocyte count in a patient in whom other sources of infection or the possible physiologic causes of leucocytosis have not been excluded are much greater than those arising from attempts to determine the condition of the teeth from radiographs alone. What is needed is not fewer leucocyte counts, but more intelligent interpretation of the information gained thereby.

This is the era of laboratories. Medical laboratories spring up almost daily, and when they are able to attach the word "research" to their titles, the height of scientific achievement seems assured. That there should be this increase in laboratory study of patients is one of the hopeful signs in medicine and dentistry. The advances in all sciences have come largely thru research carried on by laboratory workers. Further, it is obvious that for one piece of investigation which yields permanent and utilizable results, there will be many that seem at the time barren, but these are not necessarily to be discouraged. It seems desirable, however, to consider rather carefully before embarking on a time-consuming investigation whether results commensurate with the effort may reasonably be expected. Applying this idea to the study of the individual patient, would it not be well, before putting him to the expense of laboratory investigation, to determine just what is to be gained by the proposed tests, and whether these isolated tests made at various intervals, and perhaps without the controls necessary to the reliable and proper interpretation of the results can be expected to yield any information of value?

There is no more interesting or profitable field of collateral study for the physician than that of the problems of the development of the teeth, as portrayed by modern dentistry, and I believe dentists will find equal satisfaction in a survey of the changes in the body resulting from disease, the cause of which often finds expression in changes in the teeth.

Frank and friendly discussion and exchange of ideas between the two professions will lead to a better understanding of the problems of each by the other, and will render more effective efforts to prevent disease and to alleviate suffering.

Discussion

Joseph A. Capps, Chicago: During the last years the practice of medicine has been pro-

foundly influenced by the idea that a multitude of body ills are due to infection and reinfection from some primary focus of disease. The essential principle of the theory had long before been formulated by the frequently observed relationship between acute inflammatory arthritis and tonsilitis; and of gonorrheal rheumatism and urethritis or prostatitis. The theory expanded so that it embraced chronic general infections as well as acute. The primary foci were no longer limited to tonsils and prostate, but included also infected teeth, sinuses of the head, and gall bladder, and the appendix.

Many practitioners and specialists have gone to such extremes in their enthusiasm over this theory and have shown so little discrimination in its use that its real virtue is in danger of being discredited.

The hypothesis that systemic infection may have its origin in some primary focus of disease needs no defense. But systemic infection does not necessarily presuppose a chronic focus of infection. Bacteria may invade the body thru the atrium of the mucous lining of the air passages or alimentary canal or urinary tract without leaving any persistent mark at the point of entry. In pneumonia the pneumococcus may penetrate apparently normal mucous membrane, reach all parts of the body thru the blood stream, and finally disappear without a trace of diseased tissue to betray its point of origin, and similarly streptococcus sore throat occurs in individuals who have no tonsils or adenoids.

A sharp distinction should be made between an *atrium* of infection and a *focus* of infection. An atrium of infection is a point of entrance of bacteria and may be normal tissue. A focus of infection, in the words of Dr. Billings, is "a circumscribed area of tissue containing pathogenic micro-organisms." We see, therefore, that systemic infection may arise on the one hand from the penetration of bacteria thru the normal tissues, or on the other hand by the absorption of bacteria from a local area of tissue that chronically harbors bacteria.

The group of systemic infections in which a localized focus of infection can be demonstrated is fairly large and very important. But the other group in which no such focus can be demonstrated is also large and must be recognized.

I would call attention also to the futility of expecting any great benefit from eradication of infective foci in such conditions as arterial hypertension, chronic nephritis, arteriosclerosis, diabetes, and pernicious anemia. The conditions may arise from disturbances of metabolism, from faulty secretion of the endocrine glands, or from other causes not related to infection. And yet specialists are kept busy operating on patients with these ailments, offering them strong assurance of betterment or cure.

In practice the chief trouble arises, not in the acceptance of the theory of focal infections, but in its interpretation and application. Many brilliant therapeutic results have been achieved by discovering and removing foci of infection. Many also are the failures, following useless tonsillectomies, operations on the nose, and actually harmful extraction of innocent teeth.

I conceive that the various methods of treating systemic infections today are due largely to the psychological response of individual types of physicians to this theory of focal infections. Type one is the standpatter, who repudiates the theory *in toto*. He is satisfied to treat rheumatism with salicylates and is not concerned about its etiology. Type two is the radical who accepts the theory without reservations. He loses no time in removing tonsils, in correcting nasal deformities, in extracting all teeth with even a suspicion of infection, excising the appendix, and draining the gall bladder. He is biased in his observations and slow to change his opinions. Type three is the conservative, who searches the whole body systematically and repeatedly for evidences of focal infection. He is aggresive in his investigation, but he demands adequate proof of infection before advising an operation. He is reluctant to remove tonsils that appear normal or to extract teeth that show only a moderate inflammatory reaction about the apex, or to drain the gall bladder that is not diseased. The conservative will, in the long run, score as many successes as the radical, and he will be spared the humiliating experience of unnecessary and harmful operating. I think we will do more to promote a sound principle; to do the greatest good to our patients and do the least harm, if we practice conservation. Let us avoid hasty opinions and be willing to submit our evidence to competent and open-minded specialists, in order that the propriety of operation may be determined by conference. In this way our knowledge and treatment will improve.

Thomas L. Gilmer, Chicago: Dr. Irons has shown a comprehension of the histology and pathology of the mouth, jaws, and teeth

not often fully understood by the general practitioner of medicine and has combined these in their metastatic relation with other parts of the body in a most satisfactory manner. The study of this address will prove helpful not only to the dentist but to the physician as well.

It is true, as it was pointed out, that the knowledge of the relation existing between diseased mouths and other parts of the body is not wholly new. Like many other thoughts entertained years ago, it did not receive full acceptance, because of the lack of facilities to verify the truth of clinical observation. Miller, thirty years ago, contributed a series of articles for the *Dental Cosmos* entitled "The Human Mouth as a Focus of Infection." This probably was the first important discussion of the subject based on scientific observation. Scientific dentists have always regarded jaw infection as detrimental to health. This is indicated by the fact that for many years they have given much thought and time to the prevention and cure of alveolar abscess by root-canal treatment and filling.

The sources of secondary infection are many, and it is unfortunate for the dentist or the physician to form the habit of too closely concentrating his attention on some one part of the anatomy to the exclusion of all others, which may be equally prolific in causing metastases. While infected teeth are a common cause of secondary disease, there is the nose and its accessory sinuses, the genito-urinary tract, the large intestines, gall bladder, and other parts, all of which may be contributory, or any one may be the entire cause of a metastatic disease. If there are several contributing foci, the removal of any one of them may lighten the load carried by the patient, but a complete cure will not be brought about until all contributing foci have been eradicated. A narrow view of the subject has caused many disappointments, and, in some instances, has brought the whole matter into disrepute.

Dr. Irons has called our attention to the fact that apical infections may be secondary as well as primary. Proof of this is indicated by the death of pulps in sound teeth, which is occasionally observed; also the lighting up of apical infections of pulpless teeth not previously abscessed, which have perfect cavities and root fillings. In such cases the mouth is excluded as the source of infection. I have long entertained the opinion that alveolar abscess, in the great majority of cases, is of metastatic origin.

Our attention was also directed to three important factors in connection with infections. They are immunity, susceptibility, and the difference in virulence of the virus at different times. The knowledge of immunity is helpful to explain one of the reasons why a patient may have several chronic abscesses in his jaws at the same time and feel no inconvenience from them. The dosage of the organisms may not be sufficient, while the patient maintains his ordinary resistance, to cause harm, but if from any cause the resistance is lowered then the previous inadequate dose may be sufficient to cause a change in the abscess from the chronic to the acute form, or produce metastases. The transformation from the chronic abscess to the acute is frequently observed. Some species of animals are immune to certain bacteria under ordinary circumstances, but when they are subjected to unusual physical stress they no longer remain immune but succumb to the influence of the bacteria—a very clear illustration of a change from immunity to susceptibility.

Another explanation may be offered to account for the reason why abscessed teeth do not always cause metastases. There are two kinds of chronic alveolar abscesses. The one has a definite capsule of connective tissue which completely envelopes the abscess, walling it off from the adjacent tissues. The other has no such connective tissue as a separating wall; therefore the suppurating granulations are in direct contact with the vessels of the surrounding bone. The capsule enveloping a walled-off abscess has no vessels passing thru its wall, except at the point of attachment with the root, which it completely covers at its apex. It is easy to conceive that such an abscess is less liable to cause metastasis than is the open variety which has no barrier to prevent the free dissemination of its virus.

But the third factor mentioned must not be forgotten, that is the different effect of the same organism at different times when immunity and susceptibility do not appear to be the determining factors. A chronically abscessed tooth is removed under aseptic precautions and a violent reaction follows. The physical condition of the patient was normal as far as could be determined. To illustrate, when Dr. Moody and I were studying the bacteriology of alveolar abscess and the results of animal inoculation, I gathered material from several hundred patients. The utmost care was taken to secure uncontaminated specimens. The history of the patient and the conditions were obtained in each case and recorded when

the specimen was sent to the laboratory for study and culture preparatory to inoculation. One of these specimens was taken from a chronically abscessed tooth removed from the jaw of a middle-aged woman apparently in good health. After the removal of the tooth, the patient developed a chill followed by a high temperature. The wound reaction was slight and ordinarily would not have been considered significant. What was the cause of the reaction in this case? In a few days the unusual symptoms subsided. I was informed some days later by Dr. Moody that the rabbits inoculated with cultures from the specimen taken from this patient died immediately. The organisms were of the same species gathered from other similar chronically abscessed teeth and no peculiar cultural characteristics were observed. We must conclude in this instance that it was not a matter of susceptibility of the patient, but one of increased virulence of the virus, which was disseminated by the operation. Had I removed several abscessed teeth for this patient at the same time she would probably have died. Occasionally there seem to be epidemics of acute alveolar abscess. Is this due to heavier metastatic doses or to changes in the virulence of the organisms or both?

It is refreshing to hear a physician criticize the use of the term "dead teeth" and to have him so clearly point out the differences between a "dead tooth" and one that is simply "pulpless." Another term that has recently been used by some dentists is "nonvital teeth," meaning teeth with dead pulps, but still possessing their investing membranes. Nonvital means not alive; wherefore is this term better than "dead teeth?" Its use is unfortunate.

No specialist can have the broad view that the well-trained and experienced internist has. Therefore we may best serve our patients and broaden our own view by securing his cooperation in solving difficult problems.

George F. Dick, Chicago: A short time ago I met a patient who had complained of pain in the left hip, and who was referred, first to a nose and throat man for an examination for focal infection. As he was unable to find anything which would suggest focal infection there, X-ray pictures were taken of the teeth and the case referred to a general surgeon. Then followed considerable discussion as to where the focus of infection was. The dental surgeon was firm in his belief that the teeth were all right. It so happened in that case the patient had a tumor of the hip; it was not an infection at all.

Before anything is done a great deal of care should be exercised in a general examination of the patient. Dentists are in a very fortunate position to be very positive about their findings because they have at hand comparatively accurate means of diagnosis.

I have been impressed with the difference in the cases with diagnosis of infection in some other parts of the body. For instance, a number of years ago I had occasion to examine several hundred tonsils which had been removed, and I was impressed by the difficulties in seeing anything about the inside of those tonsils and the histological picture from the appearance externally. In fact, it appeared from a careful examination that some of the tonsils which were regarded ordinarily by nose and throat men as being in such a condition as to indicate their removal were relatively free from disease other than hypertrophy, while some of the more innocent tonsils had in them, as they were opened, bad abscesses, and on further examination histologically showed evidences of extensive inflammation. I thought it was worth while to follow this up further. By weighing out parts of these tonsils I determined the number of bacteria present in those different varieties of tonsils; as a rule, the small tonsils that seemed harmless contained many more times the number of bacteria per unit of weight than did the ones which ordinarily would be considered fit subjects for removal.

Of the various foci of infection responsible for systemic disease, it is fair to say that three-fourths are about the mouth and nose and throat. For the one-fourth in the teeth there are accurate means of diagnosis.

William H. G. Logan, Chicago: I shall endeavor to confine my remarks to phases of the subjects that have not been discussed, for I agree in the main with all that has been said in the paper and in the discussions that have followed.

I desire to call your attention to the fact that it was Dr. Billings here in the West who fathered a group of men who brought to our attention and to the profession of medicine the relation existing between focal infections of nose and throat and about the teeth with systemic disease. He brought you a message that has been run far afield by many radical converts. Therefore I desire to congratulate this association upon the opportunity presented to again hear his principles reaffirmed by his three associates who occupy chairs in medicine in Rush Medical College.

In the dental profession we have a number of practitioners who contend that every tooth that contains a diseased pulp should be removed, some of whom quote Dr. Billings and his associates for the advice given. The ques-

tion arises, are we justified under any circumstances in endeavoring to save a tooth when the pulp is diseased? Certain evidence must be sought in every case, if you do your duty, before you are willing to decide for or against filling a root-canal. Before you decide that a tooth must be extracted what is the decision of all the dental schools of the United States and Canada in regard to it? So far as I know there is no dental school in America that condemns all of these teeth, and yet men who have never studied the problem under like favorable conditions have reached the decision that root-canals should never be filled. What is the evidence the practitioner should seek before deciding for or against extracting a tooth containing a diseased pulp? If you proceed wisely you should not undertake to treat a tooth for the purpose of filling the root-canal until a radiograph has been taken informing you whether there is a reasonable opportunity to fill that root-canal, because it may be so crooked and constricted that you might decide in favor of extraction, believing it to be impossible to reach the apex and fill the canal.

A further inspection of the radiograph is made to determine if the apical peridental membrane is present and if the canal can be perfectly filled. If the root is invested with a live peridental membrane about the apex and the root-canal can be made accessible and the patient has not suffered nor is suffering from any systemic disease that was caused or might be influenced by focal infection I believe it is proper practice to retain such a tooth and treat and fill the root-canal. Conversely, if you cannot gain access to the root end or if the apical peridental membrane has been destroyed and bathed with chronic infection you are not justified to do other than extract the tooth. The only rare exception to be made to the foregoing would be where the tooth in question is a single-rooted one, providing the patient is in perfect health and the pericemental destruction is but slight. I might be induced against my better judgment to amputate the root end, advising the patient that the safer course to pursue is extraction.

The term "dead teeth," as the essayist has pointed out, should never be used, but a pulpless tooth should designate the tooth under discussion.

The surgical removal of teeth is well worth discussing. Local anesthesia and block anesthesia have made more oral surgeons overnight than our historians have recorded as ever having lived. I know of no surgical principle that demands the removal of the entire anterior or buccal plate overlying a tooth that is to be extracted in order to make the infected periapical area accessible. Surgeons have found it possible when called upon to remove root ends to make a liberal opening thru the soft tissues, the bone, and the alveolar process to amputate the diseased apex, performing a thoro curettement by the aid of touch and a perfect survey of the diseased field. Since that has been successfully accomplished in the past why can we not accept it as a base for our technic and as an avenue of approach when the infected field is large. If curettement is indicated and the infected field is small it can be approached thru the socket. In a great many cases curettement is not indicated in extraction of teeth. In Dr. Gilmer's records for over two thousand cases he found only three unhealed areas, and he thought them to be cysts. In a series of between sixteen hundred and seventeen hundred cases reported before the Illinois State Dental Society I found that less than 1 per cent had not healed normally.

Let every man who uses a knife, a scalpel, or a chisel, write this motto in his room or in the hospital where he operates: "I will do no harm." As the three gentlemen occupying chairs in medicine in Rush Medical College have said, be sure by long consultation that you are neither radical nor neglectful, but be persistent and slow and careful. Wait when you do not know. It is not necessary to act quickly to eliminate chronic infection. A healthy patient with a large or small rarefied area at the root end of a tooth should not be given a clean bill of health any more than a person with a small diseased tonsil, and Dr. Dick made mention of the fact that small tonsils were more harmful than the enlarged ones. If you have a rarefied area at the root end, as shown by the radiograph, in my opinion there is an infection there. If a patient has any of the diseases mentioned by Dr. Capps I would rather insist that he have all teeth removed about which chronic infections exist; not that I would expect to cure arterial hypertension or diabetes by the removal of such teeth, but on the basis that the patient would be healthier without than with them.

My compliments to the man who thinks that all teeth must be surgically removed and who thinks that when a tooth is extracted it is necessary to curette. My compliments also to the man who feels that he must never attempt to fill a root-canal. I may be wrong but I think he is more in error than I.

AN ASEPTIC ROOT-CANAL TECHNIC FOR THE PREPARATION AND FILLING OF ROOT-CANALS

By EDGAR D. COOLIDGE, D.D.S., Chicago, Illinois

(Read before the National Dental Association, Boston, Massachusetts, August 23-27, 1920)

Introduction

THERE never has been a time when a greater or more vital problem confronted the dental profession than does at the present time in the proper handling of pulpless teeth. The extreme practice of extracting all pulpless teeth or the other extreme of retaining all teeth regardless of the condition of the tissue and alveolar process about their roots is not the best service to mankind. There are many teeth being extracted which should be properly treated and whose roots should be filled; at the same time some of the profession are failing to recognize the danger to the general health of the patient in retaining badly infected teeth involving the periapical tissue. The difficulties encountered in the operation of pulp removal and filling root-canals of most teeth are weighing down upon the profession and as a result the tendency to extract teeth requiring root-canal operations is becoming too general. The tooth which is saved by good root-canal filling is usually able to render a service to the patient unequaled by an artificial substitute. It requires much patience and skill coupled with perseverence to accomplish good results in root-canal filling, and the operator who acquires these characteristics and takes advantage of the improved equipment and the higher standards of excellence in this work will doubtless have a degree of success in proportion to his effort.

Equipment for Root-Canal Operations

Sterilizers.—The first thing in the equipment for root-canal operations is a sterilizer that is practical and efficient. For the sterilization of metal instruments any water heater in which instruments can be conveniently boiled for at least twenty minutes answers the purpose for sterilizing by boiling, and there are many satisfactory kind available for the particular needs of every office. As the sterilization of dressings, cotton, towels, and other root-canal materials has become a necessity, it is urgent for the dentist to have a suitable sterilizer for this purpose—one whose construction and operation is simple. If the operation of the sterilizer is too burdensome or there is too much time lost in sterilization there is a great temptation to neglect this most important procedure. The initial cost should not be so great as to limit the use of proper equipment in any office. There are some objections to boiling broaches, especially those with barbs. These may be subjected to dry heat at 230° for ten minutes or they may be immersed in a 10 per cent solution of lysol in water. For barbed broaches, root files, and surgical knives this form of sterilization is quite satisfactory if all

organic matter and débris is thoroly cleansed from the instruments before immersing them in the solution. The solution should be renewed daily. While

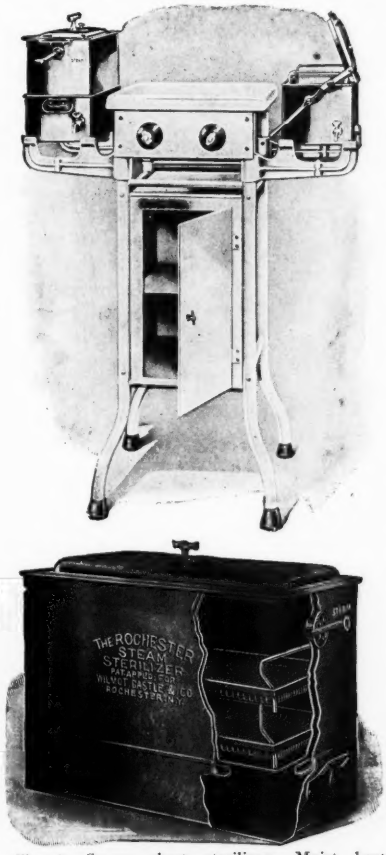

Fig. 1.—Steam chest sterilizer. Moist heat may be obtained varying from 190° F. to 215° F. and can be maintained for an indefinite period. It is necessary to maintain this temperature at least thirty minutes and is safer to sterilize three successive days before using the materials under sterilization.

the operation is underway, broaches should be immersed in 95 per cent phenol followed by alcohol before each insertion into the pulp chamber and canal. This necessitates suitable containers for these liquid sterilizing agents which are convenient and attractive. The container or medicament tray (Fig. 3) should be kept before the operator constantly and used for the purpose of maintaining asepsis of the broaches during the operation. It is quite as important to provide against contamination of the instrument while operating as it is to start with sterile instruments, and this method of immersing the broach is simple and convenient and soon becomes a matter of unconscious habit.

Root-canal instrument cabinet.—The equipment for root-canal operations should be kept separate from the other operating instruments in a small cabinet separated from all other equipment and as an aseptic precaution should be constantly subjected to formaldehyde to maintain sterilization (Fig. 4). The cabinet shelves should be removable so that a shelf and its entire contents may be taken out at one move for use as an operating tray, with the entire operating unit.

Containers.—In operating in root-canals it is necessary to use many small instruments of different sizes as well as several drugs. In order to accommodate these various articles during the operation it is well to have several small glass or porcelain dishes (minim trays) for the broaches and small cups for different drugs for use during the operation to avoid dipping into the medicine bottle. A suitable dish with compartments for gutta-percha cones of different sizes and lengths (Fig. 7) may be obtained which accommodates these various pieces without their becoming mixed, thus conserving the operator's time, for they should always be prepared in advance by the assistant.

The cotton supply.—The cotton supply for root-canal operations should include sterile cotton pellets and absorbent paper points (Fig. 8). It is not necessary to wrap cotton upon a broach since the advent of the absorbent paper point. The method of keeping cotton constantly before one in a open jar and rolling it

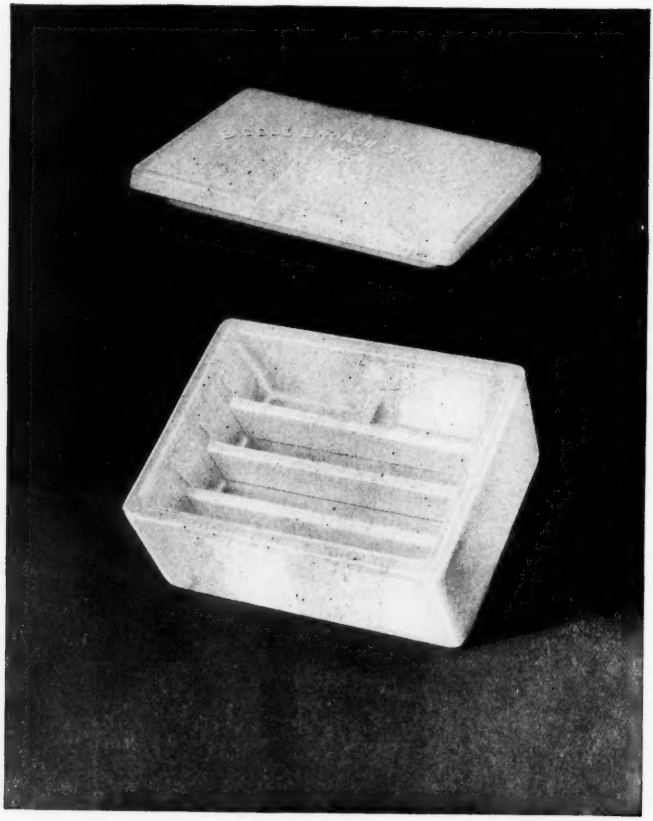

Fig. 2.—Biddle broach sterilizer. Compartments to keep broaches separate while in lysol solution.

with fingers should be abandoned because it is not aseptic without sterilization after being handled. Sterilization of cotton wrapped upon a broach is easily overlooked or neglected; hence it is far safer to abandon the loose cotton than to attempt to sterilize it after wrapping it upon the broach. When the broach is removed from the canal it usually carries débris or organic matter which must be cleaned from it. A small square of sterile gauze or muslin, five inches square fastened to a corner of the towel covering the patient is a clean and convenient means of removing such débris and adds to the neatness of the operation. A pair of small scissors is necessary to cut pellets or points to satisfactory size.

Burs and broaches.—There is a great variety of burs and broaches which may be used to advantage and different operators might vary in their selection. The spear drill for straight or contra angle, hand piece for cutting enamel, the cylinder or fissure bur No. 59, and the large round bur No. 7 are all that seem necessary. The Gates-Glidden burs are

very useful in opening the mouth of the canal to facilitate entering the canal easily with a fine broach.

Broaches should be selected in graded sizes from the XXX (triple X) fine to the fine in both smooth and barbed broaches. Shorthandled broaches are superior to long ones as the sense of touch is lessened in proportion to the distance from the working point. Broach handles should be of metal, and in order to economize the operator's time it is well to have one for each size of broach to be used. The handles should be marked to prevent loss of time in looking for the proper size. The root-canal file (Fig. 9) is an indispensable instrument for enlarging canals and should be used in the various graded sizes from extra fine to coarse.

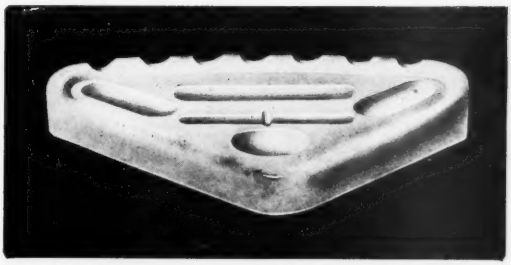

Fig. 3.—Medicament tray. Convenient tray with compartments for phenol and alcohol to sterilize broaches while operating. Other compartments for other drugs and for broaches.

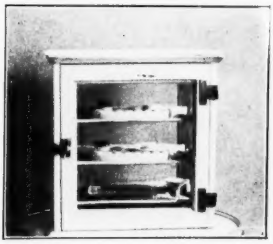

Fig. 4.—Root-canal instrument cabinet. Air-tight cabinet for formaldehyde sterilization. Shelves being removable make convenient operating trays with complete equipment for operation in place.

Root-canal pluggers.—The pluggers for packing the gutta-percha into the canal should be slender and long and with sufficient temper to stand considerable pressure. Untempered pluggers are of little use in packing. The Kerr Nos. 1, 3, 5 or the S. S. White Nos. 34, 36, 39 answer the requirements and are quite satisfactory and sufficient for usual cases.

Filling material.—At the present time gutta-percha comes the nearest to meeting the requirements of a successful root-canal filling. It can be made plastic by dissolving it in chloroform or by softening it with heat so that it can be forced and packed into all parts of the root-canal. The addition of a few grains of resin or some antiseptic drug to the chloroform before adding the gutta-percha is recommended by some operators, but the advantage of such drugs is of very little value and often it increases the difficulties of root-canal filling. The great problem of root-canal filling is the removal of the organic matter from the canal, and wherever that may be removed gutta-percha can be placed to mechanically fill the space. If organic matter is left in the canal it will decompose, and the presence of any drug is of little value to counteract the products of such decomposition. The ultimate purpose of filling root-canals is to completely fill them and to maintain a healthy periapical tissue. This tissue is subject to injury by mechanical irrita-

tion, by chemical action of drugs, or by bacterial action when invaded by virulent organisms which cause a destructive inflammatory process followed by suppuration. The filling material should be selected with the consideration of the periapical tissue as well as the complete filling of the root-canal.

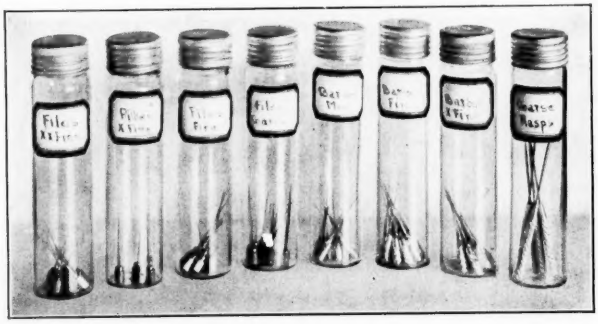

Fig. 5.—Broach bottles. Screw top bottles for surplus broach supply. Broaches sterilized and kept ready for use.

Gutta-percha answers the requirements quite well. The tissue will accommodate itself to it altho a mechanical injury is produced where it passes beyond the apical foramen. It does not absorb moisture nor is it soluble in the tissue fluids. It will not shrink away from the walls of the canal unless some other substance is added which will dissolve or evaporate. Solutions of gutta-percha will shrink, but short pieces of gutta-percha (Figs. 7 and 10) softened and packed under pressure into a dense mass will not shrink and the filling will be impervious to moisture if it seals the canal at each end.

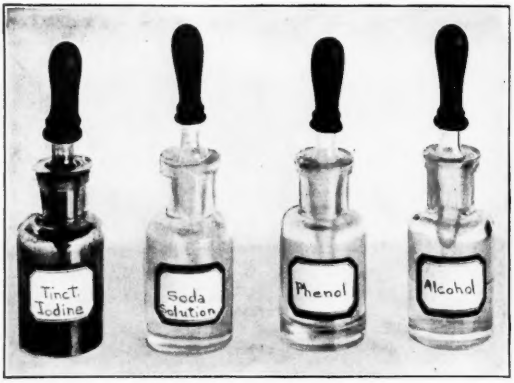

Fig. 6.—Glass dropping stoppered bottles, for dropping drugs upon the medicament tray instead of dipping into bottles.

The operating tray.—The operating tray (Fig. 11) is simply a sterile tray or perhaps a shelf removed from the root-canal instrument cabinet with suffi-

cient room upon it to hold all the instruments and materials necessary for the operation. There are two distinct advantages in this plan, *cleanliness* and *convenience.* If the shelf or tray is prepared after each operation before replacing it in the cabinet it is in readiness when needed with every instrument sterilized and all the material in place upon it. It encourages carefulness and cleanliness in the operator and assistant and gives the patient a feeling of confidence in the operator and his work.

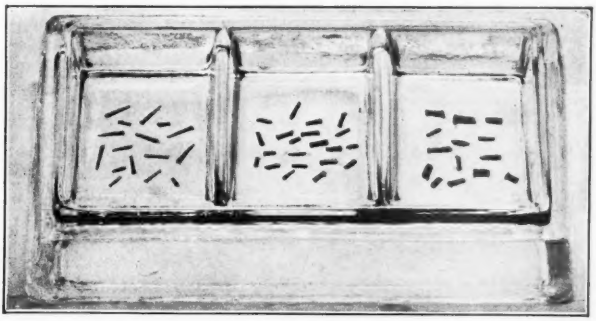

Fig. 7.—Glass container for gutta-percha cones that have been cut in short lengths ready for use.

Fig. 8—Absorbent paper points.

Fig. 9.—Root-canal files.

Upon the tray should be the aseptic medicament tray and several small porcelain minim trays for broaches of every size and style needed for the operation, sterilized cotton pellets and absorbent points, metal broach handles and root-canal pluggers, an acid loop and a pair of scissors and any other instruments or materials needed in the operation (Fig. 11).

Fig. 10.—Gutta-percha cones.

Asepsis in Root-Canal Operations

Asepsis in root-canal operations is as important as it is in any surgical operation. Doubtless, a large percentage of the infected conditions found in the periapical tissue about the roots of teeth had its origin in infection introduced during the operation of filling the root. At the present time there is no way to differentiate between the various causes of these infections found in the peri-

apical tissue about the roots of pulpless teeth. It is evident, however, that in a very large percentage of all cases showing absorbed bone areas about the root apices the root is not well filled. A careful survey of a large number of radiographs of pulpless teeth and an accurate record of the condition found show substantial clinical evidence in favor of the right kind of root-canal filling. The report of such a survey by Dr. Arthur D. Black[1] covering 1,500 radiographed root-canal fillings shows an interesting record. Dr. Black classified the fillings according to large and small canals and good or poor fillings. The roots with large and small canals showing mechanically good fillings had an evidence of periapical disturbance in only about 10 per cent of them, while the large and small canals showing poor fillings gave evidence of periapical disturbance in about 65 per cent of them. This tabulation was made in 1918 and there is no doubt that a very large percentage of the operations were completed before the campaign for greater asepsis in root-canal operations had been generally effective. It is safe to assume that with the aseptic precautions that are being used in operations today, a much better showing will be made in a similar survey a few years hence. Root-canal fillings which radiographs show to be mechanically perfect usually have a healthy periapical tissue; thus with the proper methods of asepsis in these operations of today there should be a decided improvement in the future record of results.

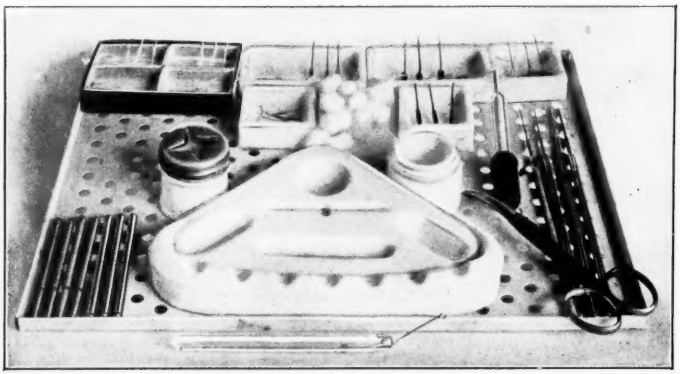

Fig. 11.—Operating tray. Aseptic tray from root-canal instrument cabinet containing complete equipment of instruments and materials used in the operation. Always ready to use if sterilized before replacing in cabinet.

[1] *Jour. Amer. Med. Assoc.*, October, 1918.

The Instruments and Material

Under the heading of sterilizers, several methods of sterilization of root-canal instruments and materials were mentioned. The all-important point is that adequate sterilization must be used. *It is not difficult to find suitable equipment for this but it is somewhat difficult to work out a routine of practice that is practical and efficient.* Where constant use is made of different instruments, all very small and hard to handle, *the routine should be as simple as is consistent with thoroness, so that adequate sterilization may never be neglected by either assistant or operator.*

The cabinet containing the root-canal unit, if constantly subjected to formalde-

hyde, will maintain sterilization and keep instruments and materials previously sterilized ready for immediate use, or they may be sterilized just previous to the operation if desired. The operation upon the root-canal may then be begun in an aspetic manner.

Preparing the Field of Operation

It is needless to say that the rubber-dam must be used in all cases of root-canal operation. Where the tooth is badly broken down it becomes necessary to cement a thin copper band around the tooth to support the clamp which holds the rubber in place. If the band is properly fitted and cemented to place without interference with the occlusion it may be left upon the tooth until the root has been filled. There are special clamps for roots previously prepared for dowel crowns which will crowd the gum back and grip the end of the root in almost all cases, thus saving the time required to fit a copper band. The canal should never be open without the rubber in place. The rubber isolates the field of operation, which is absolutely necessary to perform an aseptic operation. Just before adjusting the rubber the gums and teeth should be sprayed with an antiseptic wash and tincture of iodine painted on the gum and teeth adjacent to the tooth to be operated upon. When the rubber is in place the surface of the teeth included within the field should be again washed with tincture of iodine.

Cleaning and Enlarging the Canal

1. Gaining Access to the Pulp Chamber

The crown of the tooth should always be cut away sufficiently to expose the entire pulp chamber to view and show the openings of the canals. It is not possible to manipulate broaches around curves and angles successfully; therefore as many as possible of such obstructions should be eliminated by cutting away the enamel and dentin covering the pulp chamber. It is far better to sacrifice a little tooth structure which obstructs root-canal operations than to work at a great disadvantage and perhaps fail to thoroly clean and fill the canal.

Incisors and cuspids.—Incisors and cuspids can best be treated thru a small opening near the center of their lingual surfaces. However, when the tooth presents with a cavity on the mesial or distal surface thru which access to the canal may be obtained with very little further cutting of the enamel it is better to make the entrance thru the cavity. When entering on the proximal surface the opening of the canal should be cut well over toward the cavity to enable easy entrance of the broach into the canal. Both mesial and distal horns of the pulp chamber must be carefully opened and cleaned to prevent subsequent discoloration of the tooth.

Bicuspids and molars.—In exposing the pulp chamber of a bicuspid or molar the tooth structure should be cut away according to the requirements of each case. The occlusal opening on a bicuspid should be extended buccally and lingually sufficiently to enable the operator to see the mouth of each canal. The entire roof of the pulp chamber should be cut away and the mesial wall beveled to facilitate easy access with the instruments. The molar crown should be cut both in a bucco-lingual and a mesio-distal direction according to the shape of the pulp chamber and the location of the canal openings. The upper and lower first molars require considerable cutting toward the mesio-buccal angle, for usually the mesio-buccal canal is located directly under the apex of the mesio-buccal cusp. The entire roof of the pulp chamber should be cut away and frequently the wall on the buccal needs cutting back because the canal lies so close in the angle of the pulp chamber. If the tooth presents with a disto-occlusal cavity it is best to seal it with cement and open directly on the occlusal, cutting well to the mesial marginal ridge. Should the tooth contain a good filling

on the mesial extending on the occlusal surface it is better to remove it and enter the pulp chamber with convenience than leave it to become an obstruction later and interfere with the success of the operation. Each tooth requires a little different cutting for there is a slight variation in the shape of the pulp chambers and location of the canals of each. There is a marked variation between the first and second upper molar. However, the location of the mesio-buccal canal is usually directly beneath the apex of the mesio-buccal cusp. The opening of the canals in the molars and the buccal canals of upper molars and the upper first bicuspid canals, are difficult to enlarge and clean, and when the roots are curved or there is secondary dentin present obstructing the canal the difficulty is greatly increased.

The process of cleaning and enlarging the canal also straightens it, and the straighter it becomes the better access is obtained. A careful study should be made of the radiograph of the tooth before entering the canal and the obstructing dentin should be cut away as much as possible to allow more direct entrance

Fig. 12.—The molar triangle. Imaginary lines drawn between canal openings in pulp chamber. Drawings to illustrate location of canals in different forms of teeth. A, B, C, upper molars; D, lower molar.

floor of the pulp chamber are usually located so that if lines should be drawn connecting them they would form the sides of a triangle (Fig. 12).

The opening of the canals should not be disturbed until the pulp chamber is entirely opened so that all cuttings may be blown away and not allowed to enter the canals to clog them up. Often it is necessary to bevel the mesial wall toward the mesio-marginal ridge and cut away part of the buccal and lingual wall to bring the opening of the canals into view.

2. GAINING ACCESS TO THE APICAL FORAMEN

The object of filling root-canals is to *seal the apical foramen* after the organic matter of the pulp tissue has been removed. This objective can only be attained when there is sufficient access to the foramen to enable the operator to clean the canal thoroly and pack gutta-percha into the space. The large canals seldom give much trouble but the small canals, like the mesial canals of lower into the canal (Fig. 13). When the finest broach will pass to the foramen of the root, and it usually will if the attempt is made before any other instrument has been inserted into the canal, the process of cleaning and enlarging should be completed successfully and the canal filled perfectly. There are many difficulties that present themselves during the process of enlargement, such as packing débris into the apical third of the canal, making a ledge on the side when the broach fails to follow a curve into the canal, or losing the tip of a broach on a curve; any one of these three misfortunes make the foramen inaccessible and a complete canal filling impossible. Let us consider these difficulties for a moment. To remove the débris from a canal does not seem to be a serious problem and need not be if the broach used for cutting is frequently removed and the débris cleaned off. As the files are usually used for enlarging they do not remove the débris very well; it therefore becomes necessary to follow

with a very fine (XXX) barbed broach to rake out the fillings and shreds of organic material. This is attended by the danger of losing a point of the broach, for the canal is very small and perhaps curved and the slightest binding of the barbs upon the side of the canal may cause a piece of the broach to break away and plug the canal at that point. The other difficulty, that of making a ledge or losing the canal, is caused by using too large a broach, which will not follow the curve in the root and consequently bores a depression in the dentin at the curve instead of following the canal around the curve. When a curve is encountered the walls must be carefully filed away to straighten the canal and give *access to the foramen* (Fig. 13). The opening of the canal in the pulp chamber may be enlarged with a small Gates-Glidden drill to facilitate locating it, but the point of the instrument must always be kept in the canal to prevent making a false pocket, which would be a great handicap in the following operation. The curves should be carefully filed away and the débris removed, using the finest broaches until the foramen is reached. *A broach should never be used which is too large to pass to the foramen* until the canal has been enlarged and straightened, thus avoiding the danger of losing the canal and making a false pocket in the dentin.

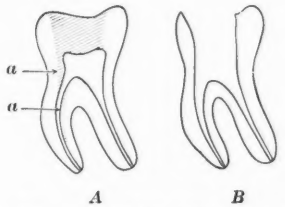

Fig. 13.—Gaining access to the apical foramen. A, drawing to illustrate curved mesial root of lower molar; B, drawing to illustrate straightening the canal. The obstructing dentin should be removed to allow a straight instrument to pass as far as possible leaving only one curve to travel. Obstructing dentin at (a) should be carefully filed and cut away without making a ledge in the dentin.

3. CHECKING UP BY RADIOGRAPH

A radiograph should be made of every tooth *before beginning* an operation in the pulp chamber or canals. Sometimes the radiograph will show a condition which makes canal operations inadvisable because of crooked roots or obstructed canals, and very frequently the periapical tissue will be found so badly diseased that the retention of the tooth might be a menace to the general health of the patient.

When the operation is under way and there is some *difficulty encountered* or some doubt as to the progress of the operation it is well to insert a wire in the canal allowing one end to be flush with the occlusal surface of the tooth (Fig. 14). After sealing up the cavity with temporary stopping, a radiograph should be taken to check up the work to this point. This is a great aid to the operator and requires but very little time and inconvenience, especially where the operator does his own radiography.

When the canal is ready to fill, a small stiff root-canal plugger such as Kerr No. 1 or the S. S. White No. 34, should pass to within 3 mm. of the apical foramen (Fig. 15). The space between the end of the plugger and the apical foramen is the most important portion of the canal as the future health of the periapical tissue is largely dependent upon the successful filling.

4. MEASURING LENGTH OF THE CANAL AND THE DIAMETER OF THE FORAMEN

The length of the canal is determined by the length of the measure wire inserted before taking the radiograph. The radiograph shows the relative length of the wire in comparison to the root. The wire should be cut so that one end is flush with the occlusal surface when it is in the canal. Frequently the radiograph gives an elongated or shortened

picture of the tooth, but the inaccuracy of the picture can usually be estimated and calculations made accordingly for one end of the wire is even with a definite surface landmark.

The diameter of the apical foramen may be calculated by the size of the plugger which will pass to it or by an absorbent paper point with the small end clipped off until it will just reach the foramen but not pass thru. With the measure wire corrected to the proper length and with a fairly close measure of the diameter of the foramen the filling of the canal may be started.

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Fig. 14.—Measuring length of canal. Wires flush with occlusal landmark.
Fig. 15.—Plugger No. 1 inserted in buccal canals. The bend in shank indicates the distance necessary to insert.
Fig. 16.—Plugger to reach within 3 mm. of foramen. The space between the plugger and the foramen is the most important of the entire space to be filled.

Filling the Canal

When the canal has been thoroly cleaned and enlarged to accommodate instruments suited for packing gutta-percha to the apical foramen it is ready for filling unless some complication is encountered. The canal must be dry and aseptic and the apical tissue in a healthy condition before a successful root-canal filling can be inserted.

The measure wire and the absorbent point used to ascertain the length of the canal and the diameter of the foramen should be upon the tray before the operator. The plugger which will pass to the apical third of the canal should be marked or bent so as to show when it is within 3 mm. of the apical foramen when placed in the canal. When it is in the canal as far as the mark, the operator has only to estimate the small space between the end of the plugger and the foramen (Fig. 16). This is the most important part of the entire filling, and the more successful the operator is in thoroly sealing the apical foramen without injury to the periapical tissue, the nearer will the result approach a perfect operation. The gutta-percha cone suitable for the canal should be selected and cut in pieces of about 3 mm. in length. It is necessary to use many more of the small ends of the gutta-percha cone than the other pieces; therefore it saves time to have a dish with compartments to contain cut points of different sizes (Fig. 7). The larger sizes, Nos. 3 and 6 (Fig. 10), furnish the best first points to be used in plugging the foramen while the smaller sizes, Nos. 8, 10 and 12, furnish better pieces for filling the middle third of the canal.

The point piece of gutta-percha suitable for plugging the apical foramen should be selected and stuck upon the end of the root-canal plugger. The plugger should be heated slightly in the flame so that the gutta-percha will adhere to it when pressed upon the larger end of the piece.

The canal should be dry before filling. It should then be slightly moistened with eucalyptol thruout its entire length. A very small amount of chloropercha

may be carried into the canal to adhere to the walls and to help in filling all the open space in the apical portion of the canal. The less chloropercha used the more accurate may be the result, since it is impossible to prevent overfilling when much chloropercha is used. The large canals require less chloropercha than the small ones since the gutta-percha points can be packed clear to the apical foramen with little difficulty. The plugger carrying the selected piece of

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Fig. 17.—Plugger No. 1 carrying first piece of gutta-percha cone selected to seal the apical foramen. Plugger is inserted to bend in shank and gutta-percha should just reach the apical foramen and be large enough to prevent passing thru the foramen.

Fig. 18.—First piece of gutta-percha cone packed in place sealing the foramen. If measurement is accurate there should be no excess filling.

Fig. 19.—Canals filled. Short pieces added one by one in the same manner packing each thoroly.

gutta-percha cone should be inserted into the canal and forced slowly down till the mark or bend indicates that it has gone to place (Fig. 17). If the measurement has been accurate this will seal the foramen, since the gutta-percha on the end of the plugger should just reach the foramen when the plugger is inserted as far as the mark (Fig. 18). Selected pieces of cut cones, softened slightly by warming, should be packed into the canal until it is full. After sealing with a hot burnisher the filling is complete.

A radiograph should then be taken to prove the filling (Fig. 19), and unless it is satisfactory it should be removed and the canal refilled.

To Remove Root Fillings

Gutta-percha root-canal fillings can easily be removed by softening them as much as possible with a heated small root-canal plugger or explorer and by flooding the pulp chamber with chloroform or xylol. The last-named drug will soften gutta-percha very rapidly but care must be used to prevent it from passing thru the foramen, for it is quite irritating. Xylol should never be sealed in the tooth. Chloroform or eucalyptol may be sealed within the pulp chamber for twenty-four hours to good advantage in some cases. Root-canal fillings of cement are extremely difficult to remove as it is so hard that the instrument will not follow it. Hydrochloric acid will sometimes assist but it must be used with great care and must be neutralized with a solution of sodium carbonate. The difficulty of removal is one of the chief objections to the use of cement as a filling material for root-canals.

Recording

A complete record should be kept of every tooth having root-canal operations. The record should begin with the condition of the pulp and periapical tissue before the operations are begun and should include the method of pulp removal, the drugs used in the treatment, and the method of sealing the treatment in the tooth. If we had a record today of the condition of the periapical tissue surrounding the teeth before the root-canal fillings were inserted it would be possible to differentiate between some of the causes of the absorptions of peri-

Dental Pulp Case History

Patient's Name _____ Age _____

Patient's Number _____ Address _____

Tooth		Diagnosis						Color		Removal			Treatment			Sealing		Root Filling					Subsequent Radiograph				Color	
RIGHT	LEFT	Vital, Normal	Vital, Hyperemia	Vital, Caries	Dead, No Abs.	Slight. Abs.	Abs. Extract	Previous R. F.	Normal	Discolored	Arsenic	Cocain, Pres.	Infiltration	Conductive	Date, Removal	Creosote	Eugenol	1-2-3	Gutta-Percha	Cement	Length, mm.	Gutta-Percha	C. P. and G. P.	Inacces. Apex	Good	Fair	Resection	Bone O. K.	Slight Abs.	Abs. Extract	Uncertain	Normal	Discolored

Fig. 20.—Dental pulp case history suggested by Dr. Arthur D. Black, Chicago. This chart is printed on an envelope, the illustration being actual size. The history is to be made out as the case progresses, the radiographs to be kept in the envelope. If the pulp is dead or if the root has been previously filled the patient is required to have a radiograph made before treatment is begun.

1. Enter patient's name, age, and address.
2. Indicate tooth by number or letter.
3. Diagnosis: (a) If the pulp is vital and normal and is to be removed because a crown is to be made, or if it is accidentally exposed in cavity preparation, mark X in first column. (b) If pulp is vital and is removed on account of hyperemia which has developed into inflammation, mark X in second column. (c) If pulp is vital and exposed by caries or so nearly exposed that its removal is required, mark X in third column. (d) If pulp is dead, mark X in fourth, fifth, or sixth column, according to the condition shown by the radiograph. It will be considered a slight abscess if any injury to the bone is shown and treatment is undertaken. It will be marked in column "Abs. Extract" if treatment is not advisable. (e) If there is a previous root filling, mark X in the last column, also an X in column four, five, or six, according to the condition shown by the radiograph.
4. Color of tooth: Mark X in proper column.
5. Removal of pulp: (a) If arsenic is applied, enter date in figures in proper column as 5-2-16. (b) If cocain-pressure is used or novocain anesthesia, infiltration or conductive, enter date in proper column. (c) Enter date of pulp removal in proper column. This date is to be entered if arsenic was applied or if the tissues were anesthetized or if the pulp was dead.
6. Treatment: Enter date of application of medicaments. If a second treatment of the same drug is made, enter date on second horizontal, etc. Doubtless many dentists would prefer to have other drugs entered in these column headings.
7. Sealing: Mark X in proper column.
8. Root filling: (a) Mark in first column length of tooth from occlusal surface or incisal edge in millimeters, making measurements with a fine smooth broach and using a Boley gauge. If the crown is broken off, so state at bottom edge of envelope. Place diagnostic wire and have radiograph made. (b) Mark date in second or third column to indicate gutta-percha alone or chloro-percha and gutta-percha used as root filling. (c) If canal is inaccessible to apex, indicate by fraction ¼, ½, or ¾, etc., according to distance diagnostic wire shows in radiograph. (d) Have radiograph made of root filling. Mark X indicating whether it is considered a good or a fair filling. In case it is a poor filling a new root filling should be made, also another radiograph. (e) In cases of teeth having more than one canal, use a separate horizontal line for each canal and indicate each by writing the initials, as m-l, m-b, d-b, dis., ling., buc., etc.
9. Resection: If root is resected, enter date in this column.
10. Subsequent radiograph: It is the intention to have patients return in about six months and make a check-up radiograph. When this is done the date should be entered in the proper column, indicating the condition of the bone at that time. Additional radiographs should be made after several years.
11. Color: The color of the tooth will be marked by the date of a subsequent examination (Dental Summary, XXXIX [October, 1919], 749).

apical tissue. As we have not such data we can only class all absorption together. A very useful form has been suggested by Dr. A. D. Black of Chicago, whereby such a record may be kept with very little inconvenience and loss of time (Fig. 20). Teeth that are healthy or that can be made healthy should be saved, for it is the duty of the profession to master this great problem and successfully clean and fill root-canals so that they may be retained with safety to function in mastication as nature intended.

CONDENSED RECAPITULATION OF ASEPTIC ROOT-CANAL EQUIPMENT

1. Sterilizers:
   1. Autoclave or Weeks, or Wilmot-Castle Steam Chest
   2. Formaldehyde Cabinet, 12 × 12 or larger
   3. Biddle broach sterilizer
2. Broaches:
   1. Barbed long
      XXX Fine
      XX Fine
      X Fine
      Fine
   2. Barbed short handles
      XXX Fine
      XX Fine
      X Fine
      Fine
   3. Smooth long
      XXX Fine
      XX Fine
      X Fine
      Fine
   4. Spiral short handles
      XX Fine
      X Fine
      Fine
   5. Special burs
      1. Gates-Glidden right angle
         1. Small
         2. Medium
         3. Large
   6. Canal files short 1½" (Kerr)
      XX Fine
      X Fine
      Fine
      Medium
3. Metal broach holders
4. Canal pluggers, S.S.W. Nos. 34, 36, 39, or Kerr Nos. 1, 3, 6
5. Cotton supply:
   1. Absorbent canal points (Johnson and Johnson)
   2. Cotton pellets No. 2 (Richmond)
   3. Aseptic napkins (Johnson and Johnson)
6. Gutta-percha canal points Nos. 3, 6, 8, 10, 12 (S.S.W.)
7. Containers:
   1. Minim trays 1 × 1 and 1 × 2
   2. Small waste receiver
   3. Dish for gutta-percha points
   4. Chloropercha bottle
   5. Dropping stoppered bottles (one-half ounce)
   6. Liquid droppers
   7. Acid loop
   8. Screw top bottles for broach storage
8. Record envelopes

DISCUSSION

A. E. Webster, Toronto, Canada: It is a privilege to have the opportunity of opening the discussion on a paper of this character which deals with a subject of vital importance to the profession at the present time. I have followed the technic presented here both in practice and in teaching and find it the most successful for accurate root-canal filling with gutta-percha.

I judge this paper has two main points, the equipment and the technic of filling a root-canal with gutta-percha.

The method of filling root-canals depends very much upon the condition of the periapical tissue. The equipment depends upon the method of root-canal treatment. I am not so sure that the aseptic or antiseptic procedure would fill all requirements. I do not believe that the ordinary sterilizer is sufficient. I think an autoclave should be used if you are to have asepsis. I do not believe that dipping broaches in a little bit of liquid is quite satisfactory. I do commend to you, however, what the essayist has said in reference to keeping the hands off all instruments and equipment which have anything to do with the canal. A technic must be developed whereby we may be

able to fill root-canals without handling anything that goes into the canals, even with gloved hands. War surgery and bone grafting have taught us that things that are locked up in the body must not be handled even with gloved hands.

If there is any virtue in swabbing the tooth before the rubber-dam is put on and if there is any virtue in swabbing the tooth exposed thru the rubber-dam, then why not swab the cavity after the dressing is removed, before the root-canal dressing is taken out, because these temporary stoppings are not excluders of bacteria or infection? If there is any virtue in swabbing the tooth with an antiseptic solution, why not swab the cavity before the root-canal dressing is removed, which is supposed to be sterilized.

The essayist suggests that swabs shall be pinned to the towel upon the patient's breast I have known patients who are very fussy regarding that. They cannot keep from imagining that the dentist is wiping his instruments on his coat. It would be better to place that somewhere else. Do not attach it to the patient if you are going to wipe on it.

The essayist says that broaches should be fine enough to reach the apex and, I would add, too large to go thru. The plugger which is going to be used for attaching the first piece should be so large that it will not reach farther than 3 mm. from the apex, for then you cannot push anything thru which ought not to go thru.

The essayist said it was a matter of simplicity to attach that little point on the end of the warm plugger. I have spent a great deal of time to get it attached, especially when the patient is very tired and I have not a long while to operate. I would like to see the technic of getting it caught.

Radiographic tests are made. They are useful just as far as they go, but they do not go far enough. They are not a test of vitality or perfect mechanical root filling. I have seen many thousands of root-canals opened after they were filled. I see thousands every year in the laboratory for purpose of technical procedure. Even X-rays are limited in value.

I see no good reason why the essayist does not cover the gutta-percha filling with oxychloride of zinc, which will act as a barrier to the ingressive bacteria.

The one objection presented by the essayist to cement is the difficulty of getting it out. If he means the difficulty of getting it out so that he may treat the conditions that may subsequently threaten the apex, I think he better take more than the filling out.

I am sorry that the method presented is limited to so few teeth. It is limited to those teeth which have straight root-canals or which may have root-canals made straight. Outside of that there are a great number. It is limited to perhaps those anterior teeth, with the exception of the lateral on many occasions, quite a number of the bicuspids, and very few of the molars. Some other method of root-canal procedure will have to be devised for the balance of the teeth.

H. D. Grubb, Cleveland, Ohio: Dr. Coolidge has presented a thoro and comprehensive paper on the subject of an aseptic root-canal technic. However, I wish to emphasize the importance of avoiding injury to vital periapical tissues. Every effort should be made to keep these tissues vital, for on this factor depends, to a great extent, the retention of the teeth.

These tissues may be injured or destroyed by: (1) not following the rules of surgical asepsis; (2) by strong irritating chemicals passing thru the apical foramen; (3) by over-instrumentation, perforating the foramen in the cleansing and enlarging of the canal; (4) by encapsulation of the apex with a mass of root-filling material.

The pericementitis often resulting from perforation, encapsulation, or passing of irritating chemicals thru the foramen, even if nonseptic, is not a desirable condition. It means a lowering of local resistance and damage to tissues that normally supply a strong protective action against infection.

Dr. Black and others advise limiting the root-canal operation to the constriction of the canal at the dento-cemental junction in those cases with vital apical tissues. The part of the canal in the cementum is lined with peridental membrane and there is no reason for destroying this tissue.

Dr. Grieves states: "If by clean pulp removal we mean only dental pulp as defined by dentin, such operation need not enter nor violate the peridental membrane, thus avoiding trauma, often infected, resulting from intentional perforation, which after all, if it does not make a false opening, cleanses but one, leaving all others unclean. If by dental pulp is meant all soft tissue apically contained, considering multiple foramina, by our present methods, it is impossible to find, cleanse, and fill all such even in extracted teeth."

Dr. Coolidge's method of handling instruments and materials for an aseptic operation is excellent, altho I have found it convenient to follow the method suggested by Dr. Best. Complete sets of broaches and other instruments are placed in cotton-plugged test-tubes and sterilized in a small autoclave. Paper points and cotton pellets are sterilized in the same manner. Napkins on which to place the instruments are sterilized in the autoclave and removed as needed. Rigid surgical asepsis is of prime importance in root-canal operating.

The cleansing and enlarging of root-canals without injuring the periapical tissues require an exacting technic. The length of the canal

should be determined by the use of the measurement wire and X-ray as soon as possible after starting the operation. This information is essential to exact root-canal operating and should prevent not only perforation but the error of an incomplete cleansing and filling.

The use of fine instruments, and enlarging the canal from the apex toward the pulp chamber by curetting will prevent the packing of debris at the apex or forcing it thru the foramen. This method also will prevent the breaking of instruments.

Dr. Coolidge's technic of root-canal filling is very good, as the operator has complete control of the gutta-percha. A well condensed filling may be made without injuring the apical tissues. With the Callahan method it is difficult to avoid overfilling and forcing thru of an undesirable mass of the material, especially where the foramen is large or freely open.

Dr. Ottolengui has suggested a modification of this method that is of value. The first piece of gutta-percha is inserted as described by Dr. Coolidge. A radiograph is made to determine if this portion of the filling has been correctly placed and the patient is dismissed. At the next appointment, which should be several days afterward, to allow time for the slight contraction that occurs when chloropercha has been used, the canal is filled according to the Callahan method.

The chloroform-resin-gutta-percha solution will envelop the gutta-percha first placed, but in the time required to complete the filling the gutta-percha will not be dissolved sufficiently to allow encapsulation.

Dr. Coolidge (closing): I appreciate the remarks that have been made by those who have discussed my paper. Each man will have a way of his own in spite of all we can do. However, the nearer we can come together toward standardizing methods, the better results we will get in general thruout the country.

Both of the discussers agreed that the important point was in filling the canal without overfilling it. We are all filling the canal with the same material (which cannot be varied very much) and get equally good results. It is pretty generally admitted that gutta-percha is the best material, altho there are other things that have advantages. If we should canvass the audience we should find that there are other materials with which to fill root-canals, but gutta-percha seems the most perfect root-canal filling that we have at the present time.

There were a few points brought out in the discussion, especially by Dr. Webster, regarding the omission of certain things that would have made the paper more complete. It is difficult to get everything into one short paper.

As far as the swabbing out of the cavity is concerned, it needs hardly to be said that I do that, but I did not mention it in the paper. If we bathe the tooth we ought to bathe the cavity, and I stand corrected on that.

I was a little sorry that Dr. Webster took that stand about dipping broaches into the phenol. I cannot understand why he did so unless he failed to get my point. The broach should be sterilized before the operation. But I maintain that during the operation some contamination of the broach occurs. There is not one man in a thousand who will have a dozen broaches of the same kind, mounted and ready to use, so as not to use the same broach twice. A man is therefore infinitely safer if he becomes accustomed to dipping that broach into a strong disinfectant, such as 95 per cent phenol, and dipping it in alcohol afterward, to prevent it injuring the patient, each time before he puts it into the patient's mouth. I have not yet seen an operator who sometimes during the technic of filling a root-canal would not contaminate his instrument either by touching it with his finger or by laying it down upon something that was not perfectly sterile. We must remember that we are not operating in the surgeon's room in a hospital. We do not have around us a coterie of nurses to hand us things and therefore we cannot quite follow the technic of the surgeon in his operation. But the points I have tried to bring out are such as would apply to every operator, no matter where he is located or what condition he has to meet in his practice. I believe that the habit of dipping the broach into the phenol and the alcohol should not be looked upon as unimportant, for it will assure asepsis during the operation, which is just as necessary as having asepsis at the beginning. Dr. Grubb differed a little in the method of sterilizing and using his instruments, but that is a matter in which each man will vary. I am glad that there were points brought out that I omitted for it stimulates the attention of the audience, and adds much value to the subject.

TRANSITION PHENOMENA IN AMALGAMS[1]

By ARTHUR W. GRAY, Ph.D., Milford, Delaware

(Transactions of the American Institute of Mining and Metallurgical Engineers, Columbus Meeting, October, 1920)

THE thermal analysis of a metal or an alloy is ordinarily made with the aid of heating and cooling curves in which transitions are indicated by the rapid changes in curvature that accompany changes in the rate of heat absorption or evolution. Analysis by the method that depends on the change in thermal expansivity is not customary, partly, at least, because of the difficulties involved in making the necessary measurements. However, under certain circumstances, the dilatometric method of analysis may possess advantages over the thermometric method that will justify the additional trouble required.

The addition of 1 per cent of zinc to an alloy has been found to produce upon the volume changes that take place during transition effects that suggest the possibility of using the dilatometric method of thermal analysis as a rather sensitive means of obtaining chemical information. Altho the illustrations presented in this paper are drawn from data obtained during an investigation of dental amalgams, similar phenomena can doubtless be observed with other alloys.

Some of the results found during an investigation made in 1917[2] have been confirmed by data on the thermal expansivity of amalgams published by Souder and Peters of the Bureau of Standards in reporting tests of dental materials.[3] Altho the Bureau of Standards made experiments for the purpose of discovering effects of including zinc as one of the constituents of a dental alloy—a matter much discussed in dental literature but without the presentation of reliable experimental evidence to support the views of either side—the reports of the tests made by the Bureau give the impression that certain striking phenomena associated with the presence of zinc were not noticed. Among such phenomena are those connected with the conditions that determine whether or not a specimen of amalgam becomes covered with droplets from which crystals develop.

Crystal Growth During Transition

During the earlier investigation, and also during various crushing strength tests, the author had noticed that amalgams from alloys containing 1 per cent or so of zinc became studded with brilliant crystals when heated into the transition region, while similarly treated amalgams from non-zinc alloys did not.

These crystals which apparently belong to either the hexagonal or the orthorhombic system, are beautiful six-sided tablets that project from the surfaces of the amalgam test cylinders.

[1]Reprinted by permission of the American Institute of Mining and Metallurgical Engineers.

[2]A. W. Gray, "Metallographic Phenomena Observed in Amalgams," Trans. Amer. Inst. of Mining and Metallurgical Engineers, LX (1919), 657-97; Jour. Nat. Dental Assoc., VI (1919), 513-31, 909-25.

[3]W. H. Souder and C. G. Peters, "An Investigation of the Physical Properties of Dental Materials," Dental Cosmos, LXII (1920), 305-35; Bureau of Standards, Technical Paper No. 157 (1920), pp. 1-40.

All the test cylinders upon which observations have been made were prepared in the manner described in the previous paper,[4] and the conditions likely to influence results were definitely known and controlled. In particular, each specimen was molded under a measured packing pressure applied to the piston that condensed the amalgam into a test cylinder. The amalgams were made from alloys having approximately the compositions given in Table I. These alloys will hereafter be referred to by the letters at the heads of the columns in the table.

TABLE I

COMPOSITION OF AMALGAM ALLOYS*

	A	B	C	D	E	F	G	H
Silver	75	69	68	68	68	70	70	54
Tin	20	26	27	26	26	27	27	30
Copper	5	5	5	5	5	3	3	16
Zinc	0	0	0	0	1	0	1	0
Total	100	100	100	99	100	100	101	100

*The composition of each alloy is here stated in terms of parts by mass. That of alloy D is expressed in such a way as to point out that D is made by omitting the 1 per cent of zinc from alloy E. Similarly G is made by adding 1 per cent of zinc to an alloy having the composition F.

Since the specimens were concealed within an oil bath or within an electric furnace while the thermal analysis measurements were in progress, some specimens were also placed in glass test-tubes and immersed, with a mercurial thermometer, in a beaker of water that was slowly heated by a Bunsen burner. It was then found that whenever amalgams containing zinc were heated into the transition region, minute drops resembling mercury oozed thru the surface at numerous points and gradually increased in size. As a rule, the drops were not noticed until the water surrounding the test-tubes reached a temperature of about 80° C.

When amalgam cylinders from alloy E that were some months old, and therefore thoroly hardened, were warmed until the droplets appeared, and then were cooled gradually, crystals suddenly developed when the temperature of the water-bath reached about 62° C. The crystallization temperature seems to be rather sharply defined, and to be, at least approximately, the same for amalgams molded under 100 kg. per circ. cm. as for amalgams molded under 800 kg.[5] The packing pressure, however, exerted a marked effect on the size and the distribution of the droplets and crystals. As the pressure increased, the droplets and crystals became smaller and more numerous, as shown by Figures 2 and 3. By heating for a sufficient time cylinders that had been packed under 100 kg. per circ. cm., so much mercury could be driven out that some would remain in the liquid state after the crystals had formed and the amalgam cooled to room temperature.

In the case of amalgams that were only a few hours old, fewer drops were exuded, but they were considerably larger. Upon cooling, the crystals seemed to form more gradually and in somewhat rounded groups. In general, the faces and angles were not so sharply defined. The blurring of the crystal boundaries, possibly because of excess mercury, was particularly noticeable when the packing pressure was fairly low. Figure 4 shows a cylinder from alloy E packed under 100 kg. per. circ. cm. and heated when about two hours old.

Non-zinc amalgam cylinders old enough to have become thoroly hardened yielded no drops or crystals upon heating, except in two cylinders a year old made from alloy D that had been packed under a pressure of 25 kg. per. circ. cm. The high mercury content that ordinarily

[4] A. W. Gray, loc. cit.

[5] As in the author's previous paper on amalgams, all pressures are for convenience expressed in terms of kilograms-weight per circular centimeter. This is analogous to the current practice of using the circular mil as a unit for expressing cross-section areas of wires. The use of the circular centimeter instead of the square centimeter avoided much unnecessary computation in expressing the results of about five thousand tests on cylindrical specimens 1 cm. in diameter.

1 kg. per circ. cm. = 4 kg. per sq. cm. = 18.10 lb. per sq. in.

accompanies such a low packing pressure was increased by the addition of surplus mercury expressed during the condensation of the amalgam. This surplus coated the surfaces of the cylinders when they were removed from the mold, and diffused inwardly as the amalgam hardened. The crystals that formed on these cylinders (Fig. 5) were smaller and fewer than those observed on zinc amalgams under similar conditions.

Freshly prepared amalgams from non-zinc alloys exuded droplets; these, however, unlike the droplets exuded by the amalgams from zinc alloys, did not, as a rule, develop crystals. Usually, these droplets became reabsorbed as the heating continued, or as the amalgam cooled. Whenever crystals did form after heating freshly prepared non-zinc amalgams, they were very few and very small. Figures 6 and 7 show crystals on cylinders from alloy D a few hours old; the first was packed under 25 kg., the other under 400 kg. per circular centimeter.

Fig. 1.—Crystals developed during transition of dental amalgam containing zinc. Magnifications 2 and 20 diameters.

Thermal Expansion

Thermal-expansion measurements were made by means of the lever dilatometer used for reaction-expansion measurements.[6] The cylindrical specimen of amalgam was directly immersed in a slowly heated bath of stirred oil. Observations of temperature and of change in diameter of the specimen were taken once a minute.

[6]A. W. Gray, loc. cit., p. 681.

The dilatometer indicated not the total expansion of the specimen, but the difference between this and four-fifths

Fig. 2.—Amalgam from zinc alloy E; packed under 100 kg. per circ. cm. and heated some months later. Magnification 4 diameters.

the expansion of a similar cylinder of invar, which formed part of the instrument. Since a knowledge of the exact

Fig. 3.—Amalgam from zinc alloy E; packed under 800 kg. per circ. cm. and heated some months later. Magnification 4 diameters.

expansivity of this invar cylinder was unnecessary, it was not determined. Therefore, the thermal expansivity values given later must be increased by adding to each the same correction, approximately one millionth. In determinations of reaction expansion, this correction vanishes, because the measurements of a given specimen's diameter changes are all made at the same temperature.

The amalgams from the non-zinc alloys tested yielded expansion-temperature curves similar to those in Figure 8, which represents an amalgam made from alloy F. The curves show results of heating the same specimen on successive days; the arrows indicate the direction

Fig. 4.—Amalgam from zinc alloy E; packed under 100 kg. per circ. cm. and heated two hours later. Magnification 4 diameters.

of the temperature change. The observations were so close together that it was impossible to distinguish individual measurements. Dash lines connect points corresponding to the last observation of one day and the first observation of the following day.

The typical curve for a non-zinc amalgam is characterized by an almost straight portion that slopes upward until the transition begins, when a rapid drop to a sharp minimum occurs. This is followed by a slight but rapid rise, which is succeeded by a further drop.

Reheating an amalgam yielded a curve of the same general shape as that obtained during the first heating, but with the transition region characteristics less pronounced.

In the case of certain non-zinc amalgams, especially those from alloys low in silver and high in copper (like alloy H) these characteristics, tho noticeable, were not very prominent. This observation is confirmed by the expansion curves for K and L given by Souder and Peters.[7]

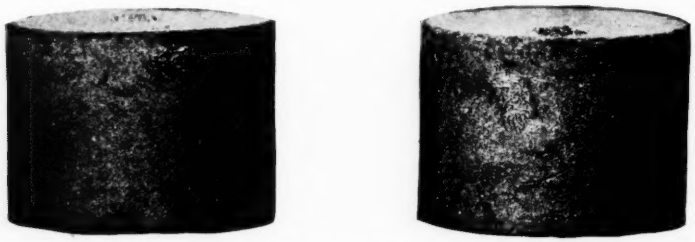


Fig. 5.—Amalgam from non-zinc alloy D; packed under 25 kg. per circ. cm. and heated one year later. Magnification 4 diameters.

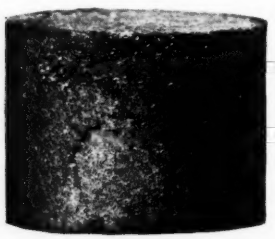


Fig. 6.—Amalgam from non-zinc alloy D; packed under 25 kg. per circ. cm. and heated one and one-half hours later. Magnification 4 diameters.

Figure 9 represents an amalgam from an alloy having the composition of C. It is the same as alloy A of Souder and Peters. As far as it goes, their curve for this agrees with that here shown, but they began cooling before reaching the maximum. Moreover, they give no data as to the behavior of an amalgam the second time it is heated into the transition region. That the contraction accompanying transition may reduce the diameter of an amalgam cylinder below the diameter it previously had at room temperature is shown by Figure 9 and by the corresponding curve of Souder and Peters.

Amalgams from zinc alloys usually yield expansion curves similar to those shown by Souder and Peters for their alloys H and B. Typical curves of this kind are also shown by Figures 10, 11, and 12. The outstanding characteristic of such a curve is a gradually increasing upward curvature, which rapidly changes into a steep rise as the transformation gets under way. Once this rapid expansion is well started, it will continue for some hours, altho the temperature be held constant, or even

Fig. 7.—Amalgam from non-zinc alloy D; packed under 400 kg. per circ. cm. and heated three hours later. Magnification 4 diameters.

[7]Loc. cit., Fig. 8.

lowered. The great influence that a little zinc exerts upon the transition is strikingly brought out by a comparison of

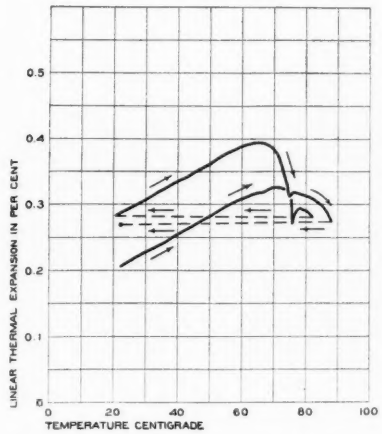


Fig. 8.—Thermal expansion of amalgam from non-zinc alloy F.

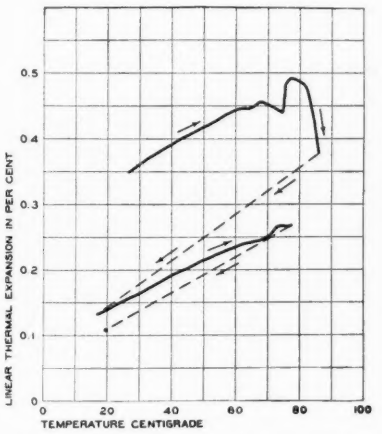


Fig. 9.—Thermal expansion of amalgam from non-zinc alloy C.

Figures 8 and 10. The test specimens for both F and G were prepared under conditions as nearly identical as possible. They were made by triturating 3 gm. alloy with 6 gm. mercury for six minutes and then molding under a pressure of 141 kg. per circ. cm. applied eight minutes. The dotted curves in Figures

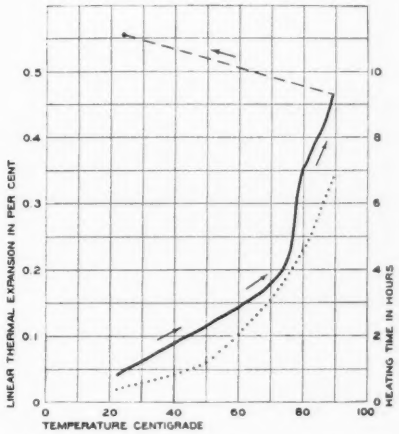


Fig. 10.—Thermal expansion of amalgam from zinc alloy G.

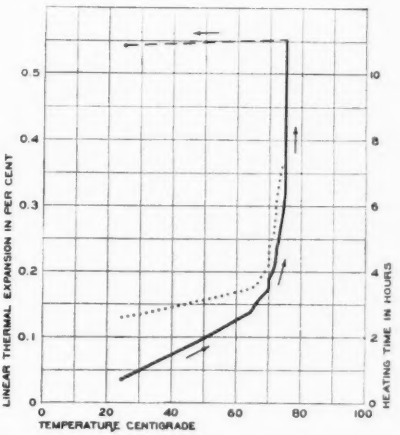


Fig. 11.—Thermal expansion of amalgam from zinc alloy E, showing continued growth at constant temperature during transition.

10, 11, and 12 indicate the rates of temperature change. The change of heating rate near 50° C. (Fig. 10) produced no noticeable effect on the

initial straight portion of the expansion curve.

Figures 11 and 12 show how the transition continues after it is once well started, even tho the temperature be held constant or even lowered. Both of these figures represent observations on alloy E. The test specimens were prepared as for Figures 8 and 10, except that the amalgam represented by Figure 11 was packed under 400 instead of under 141 kg. per circ. cm. In Figure 11, the heating rate was not reduced until just after the beginning of transition became apparent. Growth continued while the temperature was held constant at 70.0° C. for thirty minutes. Later, a continued expansion was observed for two and one-fourth hours while the specimen was maintained at 75° C.

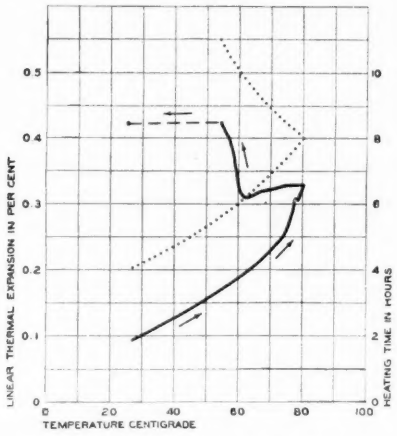


Fig. 12.—Thermal expansion of amalgam from zinc alloy E, showing continued growth even during falling temperature.

In the case of Figure 12, after the temperature had reached 80° C., heating was discontinued and the bath allowed to cool. At first the ordinary thermal contraction predominated; but as the transition got well under way, the expansion completely overshadowed this contraction, even tho the temperature had fallen considerably below that at which rapid growth began during warming. The gradually increasing upward curvature noticeable in amalgams containing zinc is very prominent in this curve, perhaps because of the high mercury content that accompanies the rather low packing pressure.

A curve similar to the first two portions of that in Figure 12 is shown by Souder and Peters for their alloy B. Their curve, however, lacks the rapid expansion that the author observed as the cooling was continued below 60° C.

That zinc exerts but little influence on the expansivity until the transition region is approached is evident. That it is not the only factor determining the behavior during transition is indicated by Souder and Peters' curve for alloy P, which begins transition with a contraction, altho it contains 5 per cent of zinc. The fact that this particular alloy contains only 60 per cent of silver may have some bearing.

Table II presents values found for the linear thermal expansivity of several amalgams near body temperature (37.5° C.). The letter following the specimen number indicates whether the measurements were made during the first or the second heating into the transition region. The horizontal line separates the data on the zinc alloys E and G from the data on the non-zinc alloys F, C, and H. As the third and fourth columns of the table indicate, the amalgamation was thoro. In each case a liberal supply of mercury was triturated with the alloy; and the trituration time was excessive for the 3 gm. alloy used in making a cylinder. The packing pressure given in the fifth column was maintained eight minutes during the molding of the amalgam.

All the specimens had been used in reaction expansion tests some months before these thermal expansion measurements were made. During the interval, the specimens had been kept in an incubator at body temperature. In the last column is recorded, in millionths

per degree centigrade, the difference between the thermal expansivity of each amalgam and four-fifths the expansivity of the invar cylinder. As already stated, a correction of approximately one millionth must be added to each value given in the table to obtain the expansivity of the amalgam itself. Omission of this correction in no way affects the determination of differences among the expansion coefficients of the various amalgams.

The amalgam from which specimen IV was made was subjected to a peculiar thermal treatment. Immediately after trituration, it was rapidly cooled by being laid upon CO_2 snow for ten minutes. Then it was softened by slightly warming it in the hand; but before reaching room temperature it was molded into a test cylinder for determining reaction expansion.[8]

Table II shows no great differences in the expansion coefficients of amalgams prepared from alloys varying considerably in composition. The range in silver is from 54 to 70 per cent; in tin, from 26 to 30; in copper, from 3 to 16; and in zinc, from 0 to 1. Warming into the transition region increased the body-temperature expansivity by a few per cent, except in the case of alloy C. In this case there was a reduction in expansivity.

The results for alloy E indicate that variations in amalgamation and in packing pressure are without much effect upon the thermal expansivity, altho such variations profoundly modify reaction expansion, crushing strength, mercury content, and other properties, especially when the packing pressure is low. The expansivity of specimen I appears to be somewhat greater than that of the other specimens from alloy E. Perhaps this is attributable to the higher mercury content resulting from the lower packing pressure.[9] The average deviation of the coefficients found for the five other amalgams from the same alloy differs from the average of the five coefficients by only ± 0.3 in 24.3, or 1.2 per cent. The difference between the smallest and

TABLE II

LINEAR EXPANSIVITY OF AMALGAMS NEAR 37.5° C.

Specimen	Alloy	Mercury-Alloy Ratio	Trituration Time (Minutes)	Packing Pressure (Kilograms per Circular Centimeter)	Expansivity (Millionths per degree C.)
I*a*	E	2.00	6	141	25.8
II*a*	E	2.00	6	400	24.2
III*a*	E	2.00	6	1131	24.2
III*b*	E	2.00	6	1131	25.0
IV*a*	E	1.60	4	400	23.8
IV*b*	E	1.60	4	400	24.2
V*a*	G	2.00	6	141	26.7
VI*a*	F	2.00	6	141	26.8
VI*b*	F	2.00	6	141	27.5
VII*a*	C	1.60	4	400	28.3
VII*b*	C	1.60	4	400	25.0
VIII*a*	H	1.60	4	400	23.3
VIII*b*	H	1.60	4	400	25.8

[8] The amalgam was subjected to this treatment in order to test a process advocated for prolonging the time that a dentist might take while inserting a filling made from one of the high-grade, and, consequently, rapidly setting alloys. Lowering the temperature retards the reaction that causes the amalgam gradually to change from a soft, plastic mass to a hard substance of great strength.

[9] Irregularities in results obtained at the Bureau of Standards with hand-packed amalgams appear to support this view.

the largest of the five values is 1.2, which is 4.9 per cent of the average.

Fig. 13.—Apparatus used for thermal analysis by modified Roberts-Austen method.

Souder and Peters report the three values 25.0, 24.7, and 28.0 for the amalgams that they prepared from substantially the same alloy as E.[10] The average deviation of these coefficients from their average is ± 1.4 in 25.9, or 5.4 per cent; the difference between the smallest and the largest is 3.3 or 12.7 per cent.

These comparatively large deviations are not ascribable to the type of expansion apparatus used by Souder and Peters, because their instrument (Priest's modification[11] of the Fizeau dilatometer) is capable of measuring small elongations with high accuracy. The deviations are due, rather, to their failure to control the packing pressure and, consequently, the mercury content of the amalgam specimens. Experiments on specimens packed by dental methods are useful for showing results to be expected in dental practice; they are not so useful when the object is to make precise comparisons of similar materials.

The similarly prepared amalgams from alloys F and G yielded almost identical expansivities at body temperature the first time they were heated; the one per cent of zinc in the latter does not show any effect until transition begins.

Thermal Analyses by Modified Roberts-Austen Method

Thermal analyses of some amalgams were made by the Roberts-Austen differential method changed so that the primary thermometer gave the temperature of the neutral body instead of the temperature of the specimen under investigation. The apparatus shown in Figure 13 was employed. The bulb of a mercurial thermometer serves as neutral body. Bound close against this by several layers of silk is one junction of a copper-constantan thermoelement; the other junction is located near the thin, drawn-out tip of the glass tube that encloses both thermometer and thermoelement.

[10]Loc. cit., p. 316. Their alloy C.

[11]I. G. Priest, "A New Interferential Dilatometer," Bureau of Standards, Scientific Paper No. 365, Bull., No. 15 (1920). pp. 669-78.

This tip is inserted in a hole drilled axially into the specimen; therefore the thermoelement determines the temperature difference between the specimen and the thermometer bulb. It was connected directly in series with a Leeds & Northrup Type P galvanometer, and with sufficient resistance to yield critical damping. The sensitivity was such that one scale-division corresponded to 0.05° C., so that readings to 0.01° C. were easily obtained.

The specimen and the neutral body, surrounded by a glass tube and a few

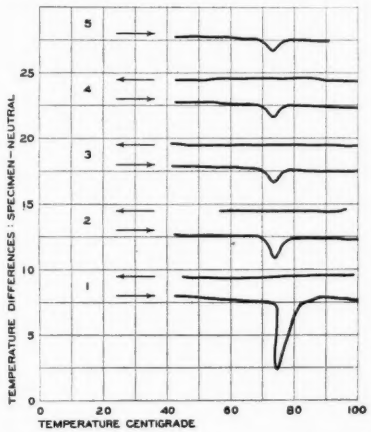


Fig. 14.—Typical thermal analysis curves, showing changes on consecutive heatings; amalgams from alloy B.

millimeters of asbestos, were simultaneously heated within a small electric furnace supplied with current from a portable storage battery. The resistor was wound around a piece of iron pipe. A thermoelement with one junction just under the heating coil and the other close to the inside wall of the pipe, indicated the radial temperature gradient. By gradually reducing the control resistance so as to keep this gradient constant while the temperature was being increased, a regular heating rate was easily maintained. This was close to 0.5° C. per minute. Both the mercurial thermometer and the thermoelement galvanometer were read every quarter minute.

A typical set of heating and cooling curves is reproduced in Figure 14, which shows the behavior of amalgam from alloy B. The arrows to the left indicate the direction of the temperature change; the adjacent numbers indicate the consecutive heatings of the same specimen of amalgam. The temperatures at the bottom of the chart are those of the specimen. The distance between one horizontal line and the next represents a temperature difference of 2.5° C. between specimen and neutral. In the following three charts the same distance represents 1° C.

The thermal analysis curves of Figure 14 exhibit the following prominent features: The first time the amalgam is warmed, the heat absorption marking transition takes place rather suddenly. It is also fairly intense, resulting in a temperature difference of about 5° C. between the specimen and the neutral body. Upon subsequent warmings, the absorption begins about 5° C. lower than upon the first warming; it also proceeds much more gradually and is completed at a lower temperature. The magnitude of the absorption is considerably less during the second than during the first heating. It is still less during the third; but thereafter little or no change is observable. The sharp minima in the several heating curves occur at nearly the same temperature, which decreases slightly with each warming. The temperatures observed upon the five consecutive heatings of this specimen were 74.4°, 73.7°, 73.6°, 73.3°, and 73.1° C. The temperature region marked by rapid heat absorption agrees closely with the region marked by the first rapid contraction in the case of the non-zinc amalgams (Figs. 8 and 9), and by the rapid expansion in the case of the amalgams containing zinc (Figures 10, 11, and 12). During cooling thruout a temperature interval 60° C., no cor-

responding evolution of heat is evident. Figure 15 is a striking example of smaller heat absorption during the second warming thru the transition region. The temperatures marked by the minima are 75.0° and 72.3° C.

Figure 16 shows the effect of adding 1 per cent of zinc to the alloy from which the amalgam is made. The lower curves represent alloy F; the single curve near the top of the chart, alloy G. The preparation and the subsequent treatment of both specimens were made as nearly

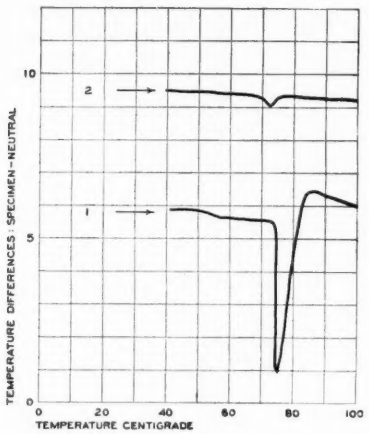


Fig. 15.—Amalgam from alloy A.

alike as possible. The addition of the zinc increased the heat absorption; also it increased from 77.0° to 78.1° C. the temperature at which the minimum appears in the curve of first heating.

Altho differences between the amalgams are unmistakably disclosed, the contrast is by no means so striking as that brought out in Figures 8 and 10 by the dilatometric method of thermal analysis applied to a pair of amalgams from the same alloys F and G. The differences obtained are not attributable to the fact that each cylinder of the pair examined by the thermometric method was prepared from 6 gm. alloy triturated with 1.60 times this mass of mercury for four minutes and molded under a pressure of 400 kg. per circ. cm., while each cylinder of the pair examined by the dilatometric method was prepared from 3 gm. alloy triturated with 2.00 times this mass of mercury for six minutes and molded under a pressure of 141 kg. per circular centimeter.

Figure 8, as well as Figure 16, indicates that the transition of amalgam prepared from alloy F starts at a lower temperature and proceeds more gradually the second time the specimen is heated.

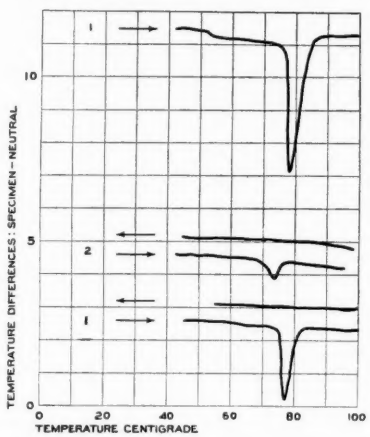


Fig. 16.—Influence of zinc; lower curves from non-zinc alloy F, top curve from zinc alloy G.

Likewise, in the second curve of each figure, the minimum appears sooner and is less prominent than in the first curve.

Figure 17 shows that increasing the packing pressure from 141 to 1131 kg. per circ. cm. reduces but little the heat absorption during the transition of an amalgam from alloy E, while it produces no clearly evident effect on either the temperature at which the sudden descent begins or the temperature at which the minimum is reached. The observed change from 77.5° to 77.2° C. is without significance.

The four alloys represented by Figures 14, 15, and 16 were all amalga-

mated under the same conditions and were all packed under 400 kg. per circ. cm. The results of subjecting their amalgams to thermal analysis afford, therefore, some information in regard to effects ascribable to variations in the compositions of the alloys. Alloys A and B both contain 5 per cent copper and no zinc. They differ only in silver-tin ratio. Figures 15 and 14 indicate that reducing this ratio from 75/20 = 3.75 to 69/26 = 2.65 makes but little change (75.0° to 74.4° C.) in the transition temperature observed on first heating. It does, however, materially lessen the reduction in heat absorption noticeable on the second curve for each alloy.

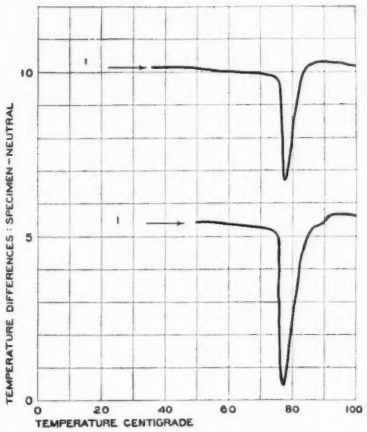


Fig. 17.—Influence of packing pressure; lower curve from amalgam of alloy E molded under 141 kg. per circ. cm., upper curve from same amalgam molded under 1131 kg.

Alloys B and F do not differ widely in silver-tin ratio (69/26 = 2.65 and 70/27 = 2.59). Reducing the copper content from 5 to 3 per cent has increased from 74.4° to 77.0° C. the temperature at which the minimum appears in the curve of first heating. It has also lessened the heat absorption considerably. Upon second heating, however, no significant difference is observable in the transition temperatures of the amalgams from the two alloys: 73.7° C. for B and 73.5° for F.

Alloys B and E have the same copper content (5 per cent), the same tin content (26 per cent), and nearly the same silver content (69 and 68 per cent, respectively). They differ principally in that E contains 1 per cent of zinc and B none. The amalgam from B packed under 400 kg. per circ. cm., shows the minimum in the curve of first heating at 74.4° C. The amalgams from E, packed under 141 and 1131 kg., show the minimum at 77.5° and 77.2° C., respectively. Thus, the results from alloys B and E confirm, to some extent, those from F and G. The addition of zinc appears to raise the transition temperature.

SERVICE AND COMPENSATION IN DENTURE PROSTHESIS

By WILLIAM A. GIFFEN, D.D.S., Detroit, Michigan

(Read before the National Society of Denture Prosthetists, Boston, Massachusetts, August 20, 1920)

THERE are two parties to be considered in the discussion of this important problem, the patient and the dentist, both of whom have suffered mentally, physically, and financially to such an extent, in the past, that it is time we made a sane effort to solve this problem. The two causes for this are: (1) the dentists have failed to educate themselves, and (2) have neglected to educate their patients as to what they may expect in denture service.

The reason for the lack of understanding on this subject is that the dental schools which are teaching, systematically, the principles of denture construction, followed by a definite denture technic, to their students and checking up on each step until the maximum efficiency in aesthetics and in comfort in their prescribed denture course is attained, can be counted on the fingers of one hand after a couple of the fingers have been amputated. This is the fundamental reason why so many fail to grasp a sufficient knowledge to encourage them to continue to make progress in this work.

Each step in denture construction should be taught the student, who would work on patients in the clinic, until thoroly understood. In practice the dentist would then be equipped to teach his patients what may be expected in denture service. In the first place the dentist, realizing his lack of ability in denture construction, must necessarily display a lack of confidence in his own ability, and in the second place it is impossible for him to educate the patient to that attitude of mind which would characterize him in the patient's mind as a man who knows what to do and why he does it. The natural result of this combination of facts is that the public places on denture service the low value that corresponds with the dentist's own estimate.

All denture prosthetists who have become proficient in this work have found such an appreciation of their efforts on the part of the patients that the difficulty of securing adequate compensation for their efforts is the least of their troubles.

While the denture prosthetist's calling occupies the largest part of his life, he should get the greatest satisfaction out of that calling. The greatest reward possible is found in the consciousness that he is rendering the best possible service to his patients. There can be nothing in the moral nature of man more discouraging or nothing that will make him more unhappy than the ever-present consciousness that he is not doing his best.

That leads us to the point, "On what basis should we start with our patient?" and the answer is, "Fair play."

We shall start on the premises that the dentist is equipped to do his part. The patient presents for denture service

either in person or by message to the secretary. If in person, the secretary, after having secured data, such as name, address, phone number, and by whom referred, presents the patient with an educational letter. This letter contains the following facts: That it is necessary to make an examination and classification of the mouth as well as the construction of study models of the case, so that the dentist may better estimate the difficulties to be overcome, and to outline a plan upon which to build the restoration, in order to obtain the greatest efficiency and best aesthetic results possible. For this examination and classification a fee will be charged, based upon the time consumed in making it. Then the appointment is made for some future date. If the patient does not appear in person, the educational letter is mailed to him.

In considering the construction of dentures for an edentulous mouth, the dentist will usually make a digital examination of the patient's mouth, allow the patient to tell him approximately what kind of a denture to make and possibly the cost; then he proceeds to make impressions and start the work.

The proper method of procedure, when the patient returns to fulfil his appointment, is to make a careful visual and digital examination of the patient's mouth conditions with the aid of a mouth mirror and probe, in order to detect any inflammatory areas or sinuses on either the upper or lower arches, tongue, floor of the mouth, cheeks, and soft palate, and to classify the muscular tone and development of the tissues; the physical size as well as the arch form and physical form of the mandible and maxilla; the condition of the soft tissues, the height of the border tissue attachments and muscular attachments, the throat form, and the salival condition.

The second step in the method is to make occluded study models of the case as an aid to making a proper diagnosis of the requirements. This furnishes an opportunity of classifying the mental attitude of the patient. These study models are of great help in demonstrating to the patient abnormal conditions as compared with normal. They demonstrate to the patient that the case is being given careful consideration and they help establish his confidence. They are especially helpful in those abnormal cases where it is necessary to resort to surgical interference in order to make a suitable foundation for the denture. This may mean the removal of abnormally placed teeth, reduction of ridges of connective tissue or mucous tissue, which has been caused by the unequal resorption of the alveolar ridge of the removal of portions of the ridge itself.

It is customary for the average practitioner to do what he has been taught in the colleges in constructing dentures. It is pitiful that so many people with unsightly dentures made over malformed jaws are forced to mingle in the society of their friends and acquaintances perfectly conscious that they have ugly mouths. The reason for this is that the family dentist did not know, or neglected to correct the deformity by surgical means when the dentures were constructed. His alibi is that he was not taught that this could be done while he was a student and had failed to use a little horse sense during his practical career. The time is rapidly passing when the dentist can afford to sacrifice efficiency in dentures as well as the personal appearance of the patient thru ignorance. Some one will inform the patient that an injustice has been done, for the unsightly conditions might have been greatly improved instead of having been made more conspicuous.

The study models have the added advantage of being utilized for the purpose of making individual trays that will require the minimum amount of material to make a correct impression. A correct or test impression must possess the following qualifications and these points should be borne in mind when making

a classification of the patient's mouth. (1) It must be properly seated with the strain on the hard and soft tissues equalized as nearly as possible, and when stress is applied to the impression it should not rock or skid. (2) It must be the proper length in order that it will not interfere with the pharyngeal muscles during the act of swallowing or coughing, nor must it be so short that it does not pass to the distal edge of the hard palate, thereby having adhesion broken when stress is applied at the anterior region. (3) The rim of the impression should be adopted as perfectly as possible to the labial and buccal aspects of the ridge and extend as far over the ridge as possible without interfering with or placing undue strain on the attachments of muscles to maxillae in order to take full advantage of all retention in a given case.

For the lower jaw the same principles must be followed, and in order to get the best adaptation, care must be exercised so that there will be no interference with the muscle attachments, especially of those attached to the mylohyoid and external oblique ridges.

The following classification, as originated and taught by Dr. M. M. House, is the most simple and complete for teaching purposes yet devised. This outline is intended for teachers and for those who assist the denture prosthetist in making a proper diagnosis and prognosis of the case, in order that he may more intelligently determine the treatment and properly instruct his patients as to what they may expect of dentures in their particular case. Any combination of the following classifications may be present and must be thoroly understood by the successful denture prosthetist. It would be absurd, unjust, and inexcusable for any denture prosthetist to allow patients with unfavorable mouth conditions to expect from their artificial dentures a service as efficient and satisfactory as that enjoyed by other patients who have favorable conditions.

Mental Classification

During consultation relative to denture service, patients should be encouraged to relate their experiences, difficulties, and expectations regarding the service they are seeking. Their mental condition may then be better understood and may be classified as follows:

Philosophical mind.—(*a*) Those who have come previous to extraction and have no experience in wearing artificial dentures; such are dependent upon the denture prosthetist for proper diagnosis and prognosis and education. (*b*) Those who have worn satisfactory dentures, are in good health, and are of the well-balanced type who may be in need of further service.

Exacting mind.—(*a*) Those who, while suffering ill health, are seriously concerned about the appearance and efficiency of artificial dentures and therefore are reluctant to accept the advice of their physician and dentist and are unwilling to submit to the removal of their natural teeth. (*b*) Those wearing artificial dentures, unsatisfactory in appearance and usefulness, who doubt the ability of the denture prosthetist to render a service that will be satisfactory; they often insist upon a written guaranty or expect the denture prosthetist to make repeated attempts without an additional fee.

Hysterical mind.—(*a*) Those in bad health, with long neglected pathological mouth conditions, who dread dental service and submit to removal of teeth as a last resort and are positive in their own minds that they can never wear artificial dentures. (*b*) Those who having attempted to wear artificial dentures have failed and are thoroly discouraged; they are of the hysterically nervous temperament, very excitable, and will demand from artificial dentures effi-

ciency and appearance equal to that of the most perfect natural dentures.

Indifferent mind.—Those who are unconcerned rearding their appearance and feel very little or no necessity of teeth for mastication. They are, therefore, non-persevering and will inconvenience themselves very little to become accustomed to the use of dentures.

Physical Classification

This includes tone and development of the muscles of mastication and expression, as follows: (*a*) A case in which degenerative changes have not occurred. (*b*) A case where approximately normal functions have been preserved by the wearing of artificial dentures. (*c*) A case in which a subnormal condition has resulted from the absence of natural or artificial dentures or from the wearing of inefficient dentures.

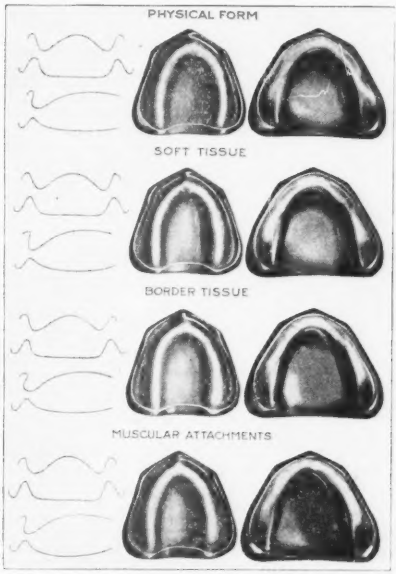
Bony structure.—Physical size: (*a*) Large upper or lower, affording the greatest possible advantages for stabilizing the dentures. (*b*) Medium size, affording less advantage for stabilizing the dentures. (*c*) Small size, presenting much difficulty in stabilizing the dentures and affording much less efficient service. Any mouth may present one class upper, and another class lower.

Arch form.—(*a*) Square type, (*b*) tapering type, (*c*) ovoid type. Any mouth may have one class of upper and another class of lower arch form.

Physical form of alveolar ridges.—(*a*) With contours favorable to the aesthetic and efficient adaptation of dentures. (*b*) With contours presenting minor difficulties to the aesthetic and efficient adaptation of dentures. (*c*) With contours which demand surgical interference to permit of aesthetic adaptation of dentures.

Soft tissues.—(*a*) Normal uniform density of investing membrane of 1 mm. or 2 mm. thickness over the area to be covered by dentures. (*b*) Hypertrophied tissue conditions resulting in thickened investing membrane which may be efficiently controlled by proper denture form. (*c*) Entire investing membrane very thin and easily irritated; may be controlled by proper denture form. (*d*) Hypertrophied tissue conditions resulting in excessive thickening of investing membrane which necessitates surgical interference.

Border tissue attachments.—Upper: (*a*) High, (*b*) medium, (*c*) low. Lower: (*a*) Low, (*b*) medium, (*c*) high.



Muscular attachments.—Upper: (*a*) High, (*b*) medium, (*c*) low. Lower: (*a*) Low, (*b*) medium, (*c*) low.

Throat form.—(*a*) Large and normal in form with the immovable tissue of the soft palate extending posteriorly from the hard area from 5 mm. to 12 mm., at which point the curtain of soft palate becomes movable with a decidedly large range of movement. This form is usually found in a large type of mouth. (*b*) Medium and normal in form, having an immovable tissue posterior to the

hard area, the curtain of movable soft palate turning down abruptly within 2 mm. of the junction of hard and soft areas. Such mouths are usually without tuberosities and present a difficult problem.

Saliva.—(*a*) Normal in quantity and quality, offering a favorable condition. (*b*) Abundance of semi-varied ropey saliva. (*c*) Excessive amount of extremely viscid saliva.

After his conditions have been classified and tabulated, the patient is dismissed and referred to the secretary, who collects the examination fee, which is based upon the time consumed, and makes another appointment with the patient, at which time the findings can be explained to him on the study models and the record of the tabulations summed up.

The dentist now ready to enter into an agreement as regards the cost to the patient for the construction of dentures and the terms of such a financial arrangement. This arrangement and agreement should be signed by the patient and be made in duplicate—the patient receiving one copy and the other copy being filed with the case record. This agreement should contain exactly what the dentist proposes to do and when his responsibility ends. The fee should be based upon the findings and consideration given to the material to be used in the construction.

NAME _____ CITY _____ STATE _____

DATE _____ PHONE _____ STREET _____

RECOMMENDED BY _____

AGE _____ HEALTH CONDITION _____

WORN PLATES	U		TEETH TO BE EXTRACTED		8 7 6 5 4 3 2 1 U 1 2 3 4 5 6 7 8		
	L				8 7 6 5 4 3 2 1 L 1 2 3 4 5 6 7 8		
KIND OF PLATES	U		DATE OF EXTRACTION	U			
	L			L			
MOULD OF TEETH	U		SHADE OF TEETH	U			
	L			L			
TREATMENT INDICATED	U		TIME REQUIRED	U			
	L			L			
STUDY CASTS	U			U			
	L		REMARKS	L			
CONTRACT PRICE	U		CONTRACT PRICE	U			
	L		REFITTING	L			
MENTAL		MUSCULAR TONE AND DEVELOPMENT	PHYSICAL SIZE	U		ARCH FORM	U
				L			L
PHYSICAL FORM	U	SOFT TISSUES U	BORDER TISSUE ATTACHMENTS	U		MUSCULAR ATTACHMENTS	U
	L	L		L			L
THROAT FORM		SALIVA	RIDGE RELATION	NORMAL		PROGNATHUS ORTHOGNATHUS	

DATE			DR.		CR.		DATE			DR.		CR.	

The dentist should be the architect or engineer of the case and be able to explain to the patient what should be done and why. The patient can readily realize that for such services and advice a consultation fee should be paid. By explaining and elaborating, the patient's attitude toward denture service and his estimate of its character and importance can be elevated so that he is well prepared to consider the amount of the fee quite secondary to the character of the operation. After the advantages in efficiency, comfort, and appearance, have been explained a basis of fair play has been established between service and compensation.

A MICROSCOPIC STUDY OF PULPS FROM INFECTED TEETH[1]

By ARTHUR T. HENRICI, M.D., and THOMAS B. HARTZELL, M.D., D.M.D.
Department of Bacteriology and Immunology, University of Minnesota

IN A PREVIOUS paper[2] we have presented bacteriological studies which indicate that in nearly one-half of the cases where teeth or their investing tissues are infected, bacteria, of which non-hemolytic streptococci are the predominant species, are already present in the pulp tissues. In concluding that paper we stated that the presence of these bacteria in the pulp "must be accompanied by some chronic inflammatory changes in the tissues." In the work here reported we have made a histological study of a similar series of pulps and have succeeded in demonstrating the chronic inflammatory reactions which we predicted.

A series of fifty vital teeth, taken as they came from the clinic, were used in this study. They were cracked open with bone-cutting forceps and dropped into Zenker's solution. After the pulps were sufficiently hardened they were carefully stripped out of the pulp chambers and imbedded in paraffin. Sections were stained with hematoxylin and eosin. With six specimens serial sections of the entire pulp were cut; and an examination of these sections indicates that, if the same procedure had been adopted for the entire series, a considerably larger number of lesions would have been found. From a number of specimens sections were also stained by the Gram-Weigert method for bacteria, but with negative results.

As in our previous study, these teeth were all (with one exception noted in the protocols) clinically vital, with pulps presenting neither discoloration nor odor on opening the pulp chamber. From six specimens, owing to technical difficulties, satisfactory sections were not obtained. Three teeth were free from caries or pericemental lesions, and these presented histologically normal pulps. Of the remaining forty-one teeth, thirteen showed pyorrhea alone, five were invaded by caries without pyorrhea, and twenty-three exhibited evidences of both caries and pyorrhea. As in our previous paper we include under caries, teeth with filled cavities where the decay has apparently been arrested.

The lesions observed fall naturally into two classes, first, inflammatory cellular infiltrations, and, second, secondary or degenerative changes including fibrosis, calcifications, and fat accumulations. The first alone, of course, can be considered as direct evidence of bacterial activity.

The inflammatory lesions can be best characterized as miliary granulomata,

[1]Aided by a grant from the Research Commission of the National Dental Association. The original report, of which this is an abstract, appeared in the Journal of Dental Research.

[2]Henrici and Hartzell, "The Bacteriology of Vital Pulps," Jour. Dental Research, I, No. 4, December, 1919.

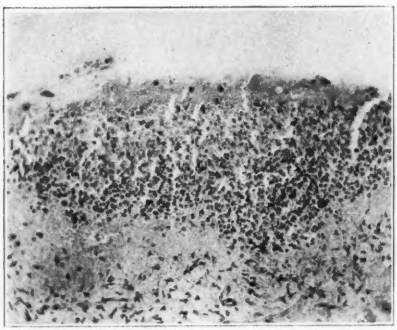


Fig. 1.—Area of subodontoblastic infiltration with lymphocytes.

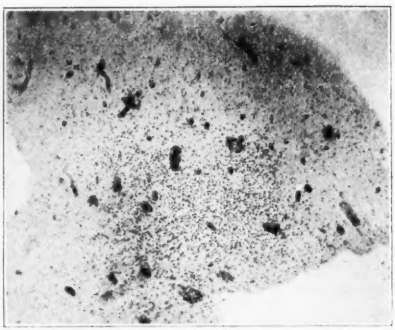


Fig. 2.—Area of inflammatory infiltration and congestion in one of the cornua of a molar.

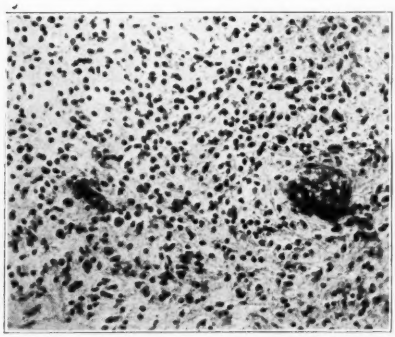


Fig. 3.—Portrion of Fig. 2 more highly magnified, showing the mononuclear character of the inflammatory cells.

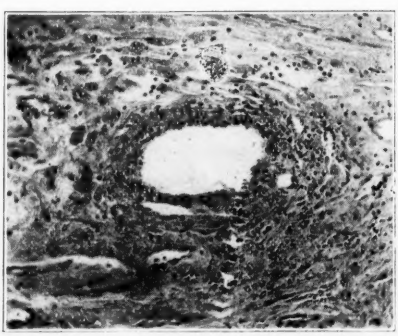


Fig. 4.—Area of necrotic tissue with polymorphonuclear leucocytes.

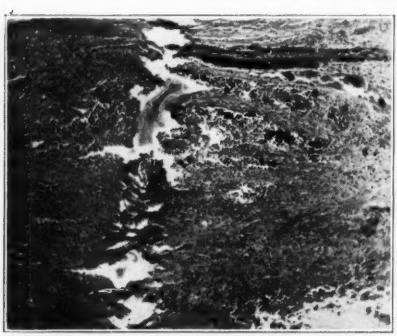


Fig. 5.—Small masses of lime salts in a granulomatous area.

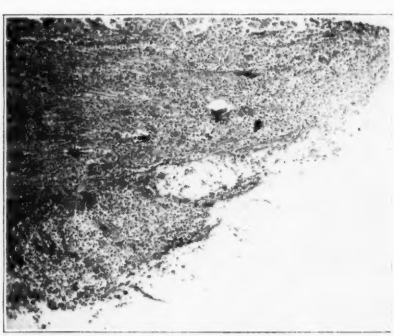


Fig. 6.—Perivascular infiltration with lymphocytes and plasma cells, surrounded by a fibroblastic reaction.

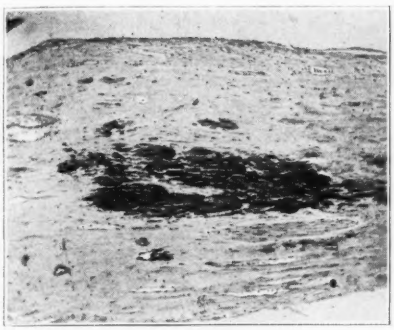


Fig. 7.—Calcified fibrous tissue in the radicular portion.

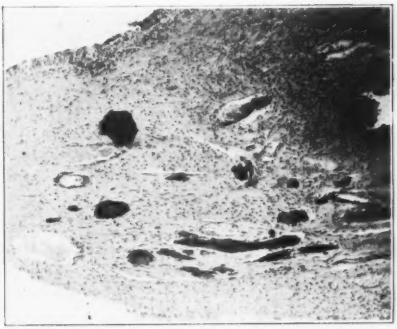


Fig. 8.—Islands of calcified material imbedded in dense fibrous tissue.

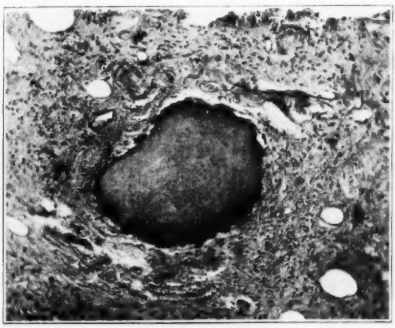


Fig. 9.—A pulp nodule in dense fibrous tissue.

since they are very small (not visible to the naked eye), usually rather sharply circumscribed, are accompanied by very little destruction of tissue, and exhibit only mononuclear leucocytes, namely lymphocytes and plasma cells, such as we are accustomed to associate with progressive chronic inflammations in other parts of the body. In only two cases have we found polymorphonuclear leucocytes; in one of these, as noted, the pulp was exposed, and in the other the pus cells were very much in the minority.

These lesions, save for their limited extent, are practically identical with the earliest lesions in the subgingival region in pyorrhea and the periapical tissues in root abscesses, as we have described them in a previous paper.[3] They are also identical with the majority of the lesions which occur in rabbits experimentally inoculated with dental streptococci. Miliary granulomata were found most frequently in the coronal portion of the pulp, usually just beneath the odontoblastic layer, but also at times free in the pulp tissue, especially in the cornua of molars.

The various lesions which we have included under the heading of secondary or degenerative changes have been well described before, especially by Hopewell-Smith who ascribes them to a variety of general causes but especially to senescence. We have, unfortunately, failed to keep a record of the ages of the patients from whom these teeth were extracted; and the series studied is too small to allow us to follow all of these changes in their natural sequence. Nevertheless, we rather believe that these changes are the result of the inflammatory reactions just described and that they represent repeated lesions of a granulomatous character which have

[3]Henrici and Hartzell, "The Microscopic Anatomy of Chronic Periodontitis and the Pathogenesis of Dental Root Cysts," Jour. Nat. Dental Assoc., IV (October, 1917), 1061-74.

Teeth		Results of Histological Examination				
Condition	Number Examined	Normal	Inflammatory Infiltrations	Fibrosis	Calcification	Fat
Normal	3	3	....	....	....	....
Pyorrhea only	13	5	1	4	6	2
Caries only....	5	0	4	3	2	1
Both caries and pyorrhea..	23	6	9	11	9	6

undergone spontaneous healing. It is self-evident that the teeth of elderly individuals are more likely to have suffered from repeated infections than those of younger persons.

The number of teeth studied is too small to warrant quantitative comparisons, either with the bacteriological studies previously reported or between the various groups in the present series, but we have expressed the results of our study quantitatively in the table.

Thus we have found active inflammation in fourteen pulps from forty-one infected teeth, or 37 per cent, ample confirmation of the opinion previously arrived at from bacteriological studies, that the pulp is invaded by micro-organisms long before it is actually exposed by caries, and repeatedly injured long before it actually undergoes necrosis.

ORTHODONTIC APPLIANCES: THEIR USE AND ABUSE

By JOHN V. MERSHON, D.D.S., Philadelphia, Pennsylvania

(Read before the National Dental Association, Boston, Massachusetts, August 23-27, 1920)

TO EXPRESS it rather broadly, oral deformities as generally understood, which the orthodontist is called on to treat, are caused by some defect in the development of the alveolar process in which the teeth are located, with the result that the teeth assume an abnormal relationship, designated generally as malocclusion. The bony process may be insufficient or excessive in quantity, or it may assume such a position that the dental arch is too narrow, too wide, or too long, as the case may be, there are many different arch forms deviating from the normal.

This maldevelopment or malocclusion, as seen in children from eight to fourteen years of age, did not occur all at once nor did it exist in its later exaggerated form at birth, but it has been gradually brought about as the result of the improper development and growth of certain tissues, which in turn have been formed into organs. These tissues and organs are furnished with nutrition, and it is thru the proper function of these organs and tissues that we have the proper assimilation of the nutrient material which produces normal growth and development. In order to have a perfect development we must have a perfect harmony in function between the different organs. It is therefore fair to assume that an imperfect development of the oral cavity as manifested in malocclusion is the result of either impaired nutrition or some disturbance in the interrelationship of function between the different organs and tissues of the body.

After the maldevelopment and malocclusion are evident even in this malrelation, there is a certain functional relationship which has grown up among the malposed teeth, the peridental membrane, the bones supporting them, the muscles of the oral cavity, the tongue, and the circulatory and nervous systems. It is the work of the orthodontist to so remold the maldeveloped bony processes supporting these malposed teeth that harmony will be established in the size and shape of the dental arches and that the malposed teeth may be restored to the position of normal occlusion with proper function and cusp relationship.

Up to the present time the only therapeutic agent that has been employed for this purpose is the orthodontic appliance. To produce a change in the shape of the bone so that a tooth may be moved from its position of malocclusion to one of normal occlusion can be accomplished only thru a process of growth. We know that slight pressure on a tooth will act as a stimulus and induce bone change thru a process of growth which will cause the tooth to change its position. This is a comparatively simple matter, but to have the tooth remain in this new position is the real problem.

Why teeth frequently revert to their former position of malocclusion we do not positively know. At one time it was taught that, when teeth in malocclusion were moved to a position of normal occlusion and the proper cusp relationship established, the mechanical locking of the cusps and the inclined planes would do much toward retaining them in their new positions. Another theory was that if we secured the proper arch form the teeth would assume and retain their proper relationship. The birth of every new orthodontic appliance designed to accomplish these purposes has raised the hopes of many and led them to thinking that their problem was solved, but we have slowly wakened to the realization that appliances alone cannot bring about this desired object.

The orthodontic problem is a developmental one in which the individual is involved and in which the orthodontist has attempted to produce a normal condition by treating locally only the oral deformity. The opinion prevails among the more experienced orthodontists that in certain types of cases, while we improve the condition, we are not able to establish a perfect (100 per cent) occlusion and retain it.

The orthodontic appliance being the only therapeutic agent at our command, there have been developed almost as many different orthodontic appliances as we have drugs for the treatment of diseases. It requires, however, just as much knowledge and judgment in prescribing and administering the orthodontic appliance as it does in prescribing drugs. Both are methods of applying a stimulus to the cells of certain tissues and organs, as all body changes must be made thru cell activity. With a drug we can overstimulate the cells and cause death, as with an overdose of strychnine; we can apply iodine as a counter-irritant to the skin and it will stimulate the cells and increase the circulation, but if too strong the overstimulation will cause the death of the cells and we say we have caused a burn. Some individuals can tolerate a large dose of a certain drug, while others may not be able to take it at all. With an orthodontic appliance we are dealing with very much the same problem, i. e., cell stimulation, and we must prescribe just as carefully and just as intelligently as the physician prescribes drugs. We must first have a thoro knowledge of the functional relationship of the tissues and the action of their respective cells for which we are prescribing.

In using an orthodontic appliance to stimulate a tooth, the pressure can be so great and continued over so long a time that the functional relationship of the teeth and supporting tissues may be disturbed and unbalanced, causing the death of the pulp of the tooth. No one questions the value of strychnine as a stimulant. Yet an overdose of the strychnine will cause the death of an individual. The death of the pulp of the tooth is not the fault of the appliance but the abuse of it.

Let us now present a brief but incomplete analysis of the function of the oral cavity as it is related to the orthodontist and orthodontic appliances. The teeth are attached to the alveolar process by connective tissue fibers forming the peridental membrane which is well supplied with nerves and blood vessels. These connective tissue fibers of the peridental membrane are attached to the tooth root and to the bony wall of the alveolar process which forms the tooth socket. The alveolar process which is a calcified connective tissue is also well supplied with nerves and blood vessels. We know

that the shape and quality of this bone, thru the action of the bone cells, can be changed or modified by the proper stimulus, such as by the action of the muscles. In proportion as these muscles are well developed and powerful, in the same degree is the bone well developed to withstand the pull of these muscles. If for any reason these muscles should cease to functionate, they would atrophy, and we would find a corresponding atrophy in the bone to which these muscles are attached because the muscles would have ceased to act as a stimulus to the bone.

It is thru the action of the muscles of mastication, the tongue, lip, and cheeks, that the teeth become functional organs and in turn react thru the peridental membrane fibers on the supporting bone, and when we apply force to the teeth thru orthodontic appliances it must be done in such a way that this normal relationship in function will not be disturbed.

Normally, each tooth is a unit having an independent motion which is a function natural to the tooth. If we fasten several teeth together with an orthodontic appliance, or if we apply a great force to several teeth over a given period of time, those teeth are denied the function which is normal to them, and the physical tone of the bone supporting those teeth will be impaired by conflicting stimuli. The natural stimulus which these teeth are accustomed to receive thru the muscles of mastication, the tongue, lips, and cheeks, would be disturbed. In both of these cases an impaired function would result, and we cannot have a normal development with impaired function. This functional relationship seems to have been entirely disregarded in the past.

If orthodontists would spend more time in studying tissue function and less on the mechanical efficiency of mechanical appliances they would have less trouble with retention. We cannot use anything we see fit to apply stimulation to teeth simply because it is mechanically perfect and efficient; it must be physiologically efficient. The profession seems to be more interested in new band material, or a material for arches, or a new type of appliance, or new instruments to be used in orthodontia. An appliance that will cause a tooth to move seems to be a sufficient reason for its adoption, with no thought as to its physiological effect.

The opinion seems to prevail that because orthodontic appliances have been recommended to the profession they are absolutely safe. The real truth, however, is that it is very difficult to properly apply them, great harm being done by their misuse and abuse. To stimulate living growing tissues with an orthodontic appliance without harm resulting is not a task for the novice. Growth is very much the same whether in the plant or the animal kingdom, yet who would think of harnessing up a delicate plant, as we do the delicate tissues of a growing child with our appliance, and expect the plant to produce perfect flowers. Davenport says: "A seedling living under a bell jar whose atmosphere contains a small quantity of ether, grows faster than one under similar conditions but without ether. If the plant is subjected to an increased quantity of ether growth is retarded." The same principle is involved when we use an orthodontic appliance as a stimulus to the living tissues which support and surround the teeth.

The change that takes place in the tissues in which the teeth are located during normal growth and development is an exceedingly complex one, and it is multiplied many times when complicated

by the stimulus from an orthodontic appliance. Just because an orthodontic appliance will produce tooth movement, it by no means justifies its use.

When we apply a stimulus to a tooth and growth increases as the result of that stimulus, the stimulation to growth continues long after the removal of the stimulus. Nature's effort is always toward the normal, and in order to allow the cells and tissues an opportunity to functionate normally rather than under an artificial stimulus, pressure should not again be applied to a tooth as long as this stimulation which has induced cell activity continues. We must not interfere with the functional relationship which exists between the teeth and their supporting tissues.

I have heard men make the erroneous statement that orthodontia has been made easy by the use of the modern appliances, but orthodontia is not an appliance problem. As the oral cavity is developed into an organ with a definite function, it is thru this function that all these tissues and organs bear a definite relationship to health equilibrium. When, therefore, we use an orthodontic appliance this function and relationship must not be unbalanced.

In the use of appliances the following should be borne in mind:

1. Teeth continue to move for a long time after the appliance has spent its force and the appliance should be so arranged that this after-growth will not be retarded.

2. Appliances should be left off as much as possible, leaving the normal processes unhampered.

3. Appliances should be so arranged that each tooth has freedom of motion.

4. The appliance should be so arranged that two or more adjoining teeth are not rigidly attached to the appliance.

5. Appliances should be used to stimulate growth, not to move teeth; let the cell activity move the teeth.

6. There is always an effort on the part of nature to develop toward the normal.

7. A tooth in changing its position in the dental arch does so as the result of a process of growth.

8. We should recognize and take into account in our treatment the difference between growth and development.

9. The rate of growth and development varies materially in different individuals; consequently the time elapsing between adjustments of the orthodontic appliance should be altered according to this growth variation.

10. We should not induce growth by artificial stimulation faster than development is taking place.

11. The amount of pressure applied to the teeth should always be the minimum amount necessary to stimulate growth and it should be varied in amount in different individuals, the same as the doses of drugs are varied.

UNTOWARD EFFECTS FOLLOWING LOCAL ANESTHESIA

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GENERAL

- *a* Intoxication by the drug used
- *b* Psychic shock or syncope
- *c* Collapse
- *d* Symptoms referable to diseased vital organs
- *e* Conditions produced by mechanically forcing toxins and bacteria into the circulation by injection into inflamed tissues[1]
- *f* Suprarenal extract

LOCAL

- *a* Local ulceration
- *b* Necrosis of both soft and hard tissues
- *c* Post-operative pain
- *d* Paralysis
- *e* Paresthesias and anesthesias
- *f* Accidents
- *g* Post-operative hemorrhage

GENERAL

(a, b, c, f)

SYSTEMIC intoxication from the drug or drugs used is seen most often in individuals who have a low-grade tolerance for the drug. One must differentiate the effect of the suprarenin from the effect of the anesthetic. Suprarenal extract accelerates the heart and causes palpitation. This often adds to the psychic shock which the patient may have and is of only a few minutes' duration. As far as I know, no serious ill effects have followed the injection of such doses as are given hypodermically in anesthetic mixtures of adrenalin—as for relief of a severe asthmatic attack ½ to 1 c. c. of a one to one thousand solution may be injected beneath the skin. Adrenalin may, however, in combination with the local effect of the anesthetic, have some influence in producing the sloughing of tissue, which we at times see. The poisonous effect upon the patient depends not so much upon the amount of the drug used, nor its strength, but upon the concentration of the drug in the circulating medium, the blood. Thus, if 1 or 2 c. c. be suddenly injected directly into a vein, the effect of this volume upon the vital centers thru which it passes will be rapid and pronounced. Consequently, one should inject the drug slowly. As the symptoms produced by a toxic dose of novocaine are many times similar to the ones manifested in syncope, it is extremely difficult or impossible to separate the one from the other; but as syncope is rarely of long duration, and recovery so complete, and its occurrence so frequent, I think we are justified in assuming that the most of these disturbances are psychic and not tonic. At any rate, each case which shows a tendency of faint should promptly be treated as serious, viz., stop injection or operation, lower the head below body level, apply cold towels to face and chest, give ammonia

[1] A. Cohn, of Berlin, reports case of myelitis following injection.

or amyl nitrate inhalations or give aromatic spirits of ammonia. If the patient passes into collapse, treat his lagging vital functions and keep up the body heat.

d) One should not attempt operation or hypodermic injection upon a patient suffering from advanced arteriosclerosis, especially of the coronary arteries. I know of one such case in which the psychic shock so contracted the already narrowed lumen of the left coronary that the circulation was cut off from the walls of the left ventricle and the patient died. If such conditions are suspected the family physician should decide as to the safety of the procedure, which should be preceded by a sedative.

e) We know from the pathogenesis of miliary tuberculosis, of multiple skin abscesses, of the recovery of bacteria from the blood stream, etc., that bacteria may be forced from their locations into the circulating medium. Consequently it is dangerous to inject anything into an abscess or infected area, as the contents of that area must necessarily be forced out and dire results may follow.

LOCAL

a) Local ulceration at site of needle puncture is probably due to unclean needle, septic mouth, or injection into tissues already inflamed and infected with bacteria.

b) Necrosis of both soft tissues and bone may occur in presence of arteriosclerosis or by using great force in infiltrating dense tissues with concentrated solutions containing large amounts of suprarenin, but is rare when gentle infiltration is made with weaker solutions. One must judge at the time he is injecting and never produce an entirely blanched area. One should avoid, unless it be necessary, the injection beneath the periostum and always inject slowly, thereby producing less trauma to the tissues infiltrated. No doubt many cases of necrosis could be avoided if all the teeth in the mouth, especially the ones to be extracted, were scaled and polished and the extraction deferred a day or two.

c) Post-operative pain is probably due to several conditions—among them a green stick fracture or springing of the alveolar walls. It is good practice to gently compress the socket after each extraction. Superficial infection of the socket from existing infection within it, or infection extending from the mouth, especially in those cases where too much ischemia has been produced and a dry socket results, may remain painful as we see at times an exfoliation of a thin cylinder corresponding to the shape of the root, really an exfoliation of the socket. This condition may be explained in the foregoing manner. The retention within the socket of an infected liquefying blood clot may also be the cause of pain as its thoro removal followed by packing with an anodyne antiseptic usually relieves the pain. Other cases are undoubtedly due to a true inflammation of the whole branch or branches of the trigeminus, possibly an ascending neuritis from the infected socket or introduction around the nerve trunk of nonsterile solutions. Possibly direct injury to the nerve trunk by the needle, or, in the lower jaw, its compression within the canal by the manipulation during extraction, especially of the third molars, may account for it. Again it seems that the nerve trunk may be compressed within the canal by inflammatory exudate or a hematoma, causing a traumatic neuritis. I am inclined to think that most often bacteria are introduced into the tissues at the time of injection. I have had very few such results after having adopted the routine of using a fresh solution and boiling both it and my needle immediately before each injection.

d) Paralysis following local infections.—At times typical cases of facial paralysis follow local injections. These are of two types: (1) The complete peripheral paralysis, due to involvement of the seventh nerve within the petrous

portion of the temporal bone, which usually has nothing to do with the infiltration but may be due to faulty technic in the attempt to block the mandibular nerve, or it may follow an inflammatory condition in the neighborhood of either upper or lower third molar. One should not attempt deep injection when there is deep-seated inflammation in the region behind the third molars. Neither should one pass a needle thru infected areas to deposit the solution at a point beyond. I have now a case on hand in which a typical Bell's palsy followed a neglected infection about an impacted lower third molar. (2) Partial paralysis only due to infiltration of some peripheral branches of the seventh nerve within the tissues of the face. Alcohol which was used to sterilize the syringe and needle and which was not thoroly removed before filling the syringe with the anesthetic solution has caused such paralysis which may last six months or more. For many reasons I prefer to sterilize by boiling.

e) Paresthesias and anesthesias.—More or less annoying areas of anesthesia or paresthesia result at times from injury by the needle to some fibers of the fifth nerve at the infraorbital or mental foramen. These will usually pass with the regeneration of the nerve within six months.

f) Accidents.—(1) One should always observe the needle after it is withdrawn to see if by any chance it has broken; if so, it should be removed at once. The patient should not be allowed to close his mouth and one should not take his eye off of the spot until it is accomplished, especially if the needle is broken in an attempt to block the mandibular nerve. One should approach the broken fragment with a sharp knife at right angles to the long axis of the needle, being careful not to force it deeper. (2) Thoro knowledge of the anatomy of the parts and their relative positions when the head is inclined and mouth opened to various degrees is necessary to avoid passage of the needle into or thru the temporomaxillary joint. This accident is not infrequent, especially in edentulous mouths, and is serious, particularly if infection be introduced. (3) Trismus of varying degree not infrequently follows the blocking of the mandibular nerve and may be avoided if sterile needles and solutions are used and if the solution is deposited around the nerve at the foramen and not into the muscular tissue or temporomaxillary joint, as has been done. Many cases of trismus are due to operative injury of the soft parts and bone, which, on account of the injury, are more apt to become infected, the trismus being reflex, inflammatory, or both. One cannot measure the virulence of the organisms nor the resistance of the tissues; consequently one should keep in mind the possibility of serious conditions which may arise from any simple injection or minor operation and should see his patient twenty-four or thirty-six hours after the operation.

I must sound a note of warning against too much nerve blocking. Local anesthetics are direct nerve poisons and we do not know the ultimate effect of repeated injections about or into nerve trunks. Possibly some of the vague neuralgias, headaches, disturbances of eye functions, tumors, etc., may be due to nerve blocking. With very few exceptions is it necessary to block the maxillary branch at the foramen rotundum or within the sphenomaxillary fossa or fissure, as the whole of the superior maxillary bone may be anesthetized by infiltration. When it is not necessary, why take the chance of injuring other very important structures or producing a basilar meningitis by so doing? Aseptic technic is a study of years and few of us become proficient. We are too ready to do what some one tells us to do. We are looking too much toward the short cut, or the easy way either to make money or to be spectacular. We should

master local anesthesia, then use our heads instead of blocking everything in sight, not knowing what may happen to the patient. I know of two cases of deep sloughing following blocking of the maxillary branch of the fifth, there being no infection present. In another, necrosis of the coronoid process followed blocking the mandibular branch. Just exactly what caused these troubles one cannot say, but I do know that if blocking had not been resorted to these conditions would not have resulted. I am inclined to think bacteria were carried into the last one and that the needle was far from the right place. The other two cases may have been due to stale solutions, stale tablets, or to the poisonous action of the drug. I am in favor of boiling solutions, syringe, and needles just before using rather than of keeping a stock solution or keeping syringe and needles in an antiseptic solution. Rarely does novocaine produce sloughing, but it has occurred in other parts of the body, the slough being sterile. When such a condition occurs in the deeper parts of the mouth or near the base of the skull it is very serious.

g) Post-operative hemorrhage does at times cause considerable anxiety to the patient and may be serious or even fatal. It is well to ask each patient if he has ever had a severe hemorrhage following an injury or extraction of a tooth. If hemophilia be suspected, the operation, unless it be imperative, should be deferred and the patient be put on a milk diet plus the administration of calcium. Chronic infected sockets are apt to bleed more freely than others and should be packed for twenty-four hours, then repacked if necessary. I prefer to use iodoform gauze alone rather than astringents or escharotics. Hemostatic serums may be used, but one should keep in mind that troublesome cases of anaphylaxis have followed their injection. At times hemorrhage seems to be kept up by a partially detached blood clot. The bleeding may continue for a day or two or until the whole clot is removed, after which one packing usually controls it. Patients should be told that if secondary hemorrhage does occur it can usually be controlled by placing a tight wad of cotton over the socket and pressing upon it either by closing the teeth upon it or by finger or thumb. The relaxation of vessel walls after the use of adrenalin probably accounts for some hemorrhages, especially if the vessels are diseased, but they are I think of little consequence if the patient be instructed how to care for them, at least until help arrives.

A recent experience prompts me to mention a case of anesthesia of the pulps of the teeth following a fracture of the jaw in which the dentist, because the pulps did not respond to his heat test for vitality, promptly removed them and filled the roots of five teeth anterior to the fracture; he did not realize that the pulps were anesthetized and not devitalized by the injury to the nerve trunk.

In conclusion let me make a plea for the mastery of local anesthesia and the use of infiltration, leading up as the necessity of the case warrants to nerve blocking rather than to block nerve trunks when a safer method will answer every purpose. It is just as logical to use spinal anesthesia for a circumcision as to block the maxillary at the foramen rotundum for anything less than a typical resection of the superior maxillary bone.

STANDARDIZING THE TECHNIC OF SURGICAL PROPHYLAXIS

By JUSTIN D. TOWNER, D.D.S., Memphis, Tennessee

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NO SINGLE subject is closer related to our professional interests than prophylaxis—especially its surgical aspect including, in its broad sense, the treatment of subgingival areas. Tho much discussed of late years, there seems to have been no concerted effort looking toward a unification of ideas or standardization of technic. Many recognize the importance of this most essential work who have not undertaken its practice because of the haze in which it seems surrounded.

We have added much to our knowledge of the etiological factors entering into diseases of the teeth and their investing tissues, but so far this has not eliminated the great variance of diagnosis, or seemingly reduced the multiplicity of methods and appliances used, either in prevention or cure. There can be no objection to the advocacy of individual theories, procedures, or design of prophylactic requisites so long as these are based upon primordial necessities and fundamental principles. Out of this mass of evidence some standard should be established by which to judge the eccentricities that tend to confuse and thus retard the development of skill. Until there is more unanimity of opinion and some fairly standardized method of procedure, there will exist a maze of conflicting theories which find expression in indifference, haphazard operation, and unsatisfactory results, all of which tend to make the expediency of this work doubted.

Surgical prophylaxis is too firmly established as a necessary aggressive procedure in the removal of existing causes of mouth diseases to require further argument in support of it. Few there are who do not admit its advantages and commend the efforts of those engaged in such practice. Many of these, however, do not make any determined effort in this work, so essential to hygienic dentistry, because no attempted systematization thus far has been appealing in its simplicity.

The great prevalence of diseases of the investment tissues alone, which has far exceeded our ability to relieve, and now threatens an edentulous race, is more the result of malhygiene and indifferent prophylaxis than anything else. The only remedy apparent for this distressing condition is the more general practice of preventive measures to the end that every member of the profession will be a prophylactician first and dentist next. The prime excuse for dentistry is health, and, aside from the relief of actual pain, that practice which best prevents disease should be the first service rendered. We have no right to prolong disease when simple and definite means are available for its prevention or cure.

A correct understanding of the anatomy, histology, and pathology of the tissues involved and the etiology of the

diseases to which they fall prey is always essential to good surgical judgment. Those who have become proficient in any kind of surgery know best the normal structures and the different pictures these present when diseased from definite causes. It must be presumed, then, that those who make any pretense at surgical prophylaxis must build their efficiency upon these fundamentals.

What seems most needed just now is a recognized instrument design, classification, and nomenclature upon which to build a simple, systematic and effective technic. With this in mind, the following practical suggestions may serve to impress their importance and make more clear certain definite principles, for in proportion to the logical application of these fundamental requirements will be one's ability to design, select, and use instruments to the best advantage: (1) surface angles of tooth circumference; (2) grouping of teeth relative to position in arch; (3) position of arch; (4) normal tooth form; (5) exposed or subgingival surface; (6) excessive free gingiva; (7) embrasures; (8) shank; (9) shaft; (10) grasp.

Surface Angles

A proper conception of the number of surface angles of the tooth circumference and the form they collectively assume is the first essential in intelligent instrument design. Viewing any tooth in direction of its long axis, we find that the eight surface angles of its circumstance represents an octagon. This suggests the advisability of having eight instruments, each with its blade at an angle of 12½ centigrades to a circle, and its working plane at right angles to the length of the blade, in order to treat these respective surfaces with precision. These should be numbered from 1 to 8, inclusive, and tho this must be done somewhat arbitrarily, on account of necessary interchangeability, it is an essential aid in working out a simple and definite technic. With instruments suitably designed and numbered, and passing in the same direction, from a given point around each tooth, it is possible to thoroly systematize and thus simplify procedure.

The varying extent of these surface angles, as presented in the circumference of crowns, necks, and roots of teeth, must be considered in determining the width of working plane. It is obvious that a width permissible on crowns would be wholly unsuited for roots; therefore a compromise must be made by the selection of a width best suited for application to all neck surfaces. From clinical experience and observation, as well as direct measurements, a width of 15 mm. seems most applicable to the variety of surface angles encountered.

The width of blade should be the same as working plane (hereafter called plane) to permit of slight hollow grinding and still maintain sufficient strength. Hollow grinding seems a departure in instruments of this type, yet its advantages are sufficiently apparent to influence adoption. The fact that it prevents the plane from assuming an oval form when sharpened, and allows the blade to be sharp on each side, thus making the instrument more serviceable, seems enough to commend it.

Group Position in Arch

With respect to the position of the teeth in the arch, it will be seen that there are three distinct groups, which may be indicated as anteriors, bicuspids, and molars. These are the same on either side of the median line in either the superior or inferior arch, and demand respective, as well as collective, consideration in the selection and use of instruments.

The position of a group, or its relative distance from the median line, should determine the angle of the blade to central axis of shaft, and suggest its length, tho it is not the deciding factor in this latter respect. Instruments properly designed to treat any given tooth

will, under even fairly normal conditions, work equally well upon all teeth of that group whether they be right or left, superior or inferior. There are, then, just three groups to consider when determining blade angles of the ordinary set. Special or extraordinary instruments, as mentioned later, are necessary to meet the demands of unusual cases and should be a part of every complete equipment.

In the anterior group, which includes the cuspids, each tooth is more exposed, and can be approached with an instrument, the shaft of which is more in line with its long axis. The angle of blade to shaft, therefore, is necessarily less in this group than in either the bicuspid or molar group. Experience has proved that a blade set at an angle of 6 centigrades to the shaft permits the most ideal approach and allows the working plane to act more positively in a greater variety of conditions.

The bicuspid group, lying at the juncture of lip and cheek, presents a somewhat different problem in that the position is lateral, more protected and in closer proximity to opposing teeth. Provision must be made in the blade angle to accommodate the instrument to this more restricted access and permit an approach which will not unnecessarily distend the tissues, or force the jaws too far apart. A blade given off at an angle of 9 centigrades to the shaft will be found to meet these requirements satisfactorily.

The molar group, being most distant from the median line, therefore more protected, and in closest proximity to opposing teeth, presents the problems found in the bicuspids in more exaggerated form. Here the distance from vestibule of mouth, less possible distension of buccal tissues, and nearness of opposing teeth all combine to limit access. To overcome these disadvantages, and at the same time allow for freedom of shaft movement, it is necessary to have a blade, the angle of which is at least 12 centigrades to the shaft. These angles, suggested for each group, are those which permit free movement of the shaft with least inconvenience to patient or operator while the blade is working in line wth the long axis of the tooth.

The length of the blade must be sufficient when properly contra-angled to make the surface under treatment most accessible, and at the same time have its plane or blade end equal to, or within 2 mm. of the central axis of shaft. This length is determined by group position, as here suggested, and tooth form, to be discussed later.

It has been found that 6 mm. blade length is sufficient in all anteriors except very long and retruded lowers, in which case the bicuspid or molar instruments, of greater angle and length of blade, work ideally. In the bicuspid group an 8 mm. blade length is sufficient for all ordinary purposes, while a 10 mm. length meets the usual requirements for molars most satisfactorily. These lengths will reach and work positively on all surfaces except those that the specials are designed to treat.

From the width of plane mentioned under surface angles, and the length and angle of blade suggested here, the following formula for ordinaries are made:

ORDINARIES

Anteriors	Bicuspids	Molars
15	15	15
6	8	10
6	9	12

Occasionally a condition arises by virtue of irregular position, malformation, unnaturally long teeth, or partially closed bite, etc., which demands an instrument out of the ordinary. These may be known as extraordinaries (or specials) and are necessary in order that one may be equipped to properly treat any unusual case encountered. They are few in number and at slight variance with bicuspid and molar formulas. Ten in all, five in each the concave and convex blades, seem sufficient. Two with plane toward the shaft should have a

formula 15-12-15, two right and two left with formula 15-10-15, and four with formula 15-12-9, two of which have plane toward shaft and two with plane away from shaft.

Position of Arch

The position of the arch, superior or inferior, must be considered separately and as a whole, when determining instrument angles, in order to select those shapes which can best be used interchangeably. An instrument with a blade at an angle sufficient to allow its plane to be used as near as possible at right angles to the long axis of either an upper or lower tooth of the same group will, of course, be applicable to either side, and is, therefore, the one to select. Interchangeability is essential to the reduction of numbers and is a great factor in the development of definite technic.

Normal Tooth Form

Normal form of crown and root determines the concavity or convexity of the blade, and with group position decides its length.

Practically all crown surfaces are convex occluso-gingivally which fact indicates that the blades intended for such areas must have a concave face. This form, provided the blades are long enough, will not only conform to crown surfaces but pass beyond and dip into constricted neck areas. Beyond this point, however, a convex blade will more nearly follow the root outline and should be used on these surfaces, especially if either or both the crown or gingival tissues are in situ. According to this, these instruments are divided into two general classes with respect to the form of blades: Those with concave blades intended for crowns and necks of teeth and those with convex blades designed for exposed and subgingival root surfaces. These should be duplicates in angle and length of blades, but not necessarily so in thickness and plane.

The trifurcation of the upper and bifurcation of the lower molar roots suggests another set of eight instruments, which may be termed bifurcation curettes. These should be very delicate: .8 mm. wide, 12 mm. long and 15-centigrade angle. The blade may be slightly hollow ground, as in other instruments, and the working point given off at a gradual curve with oval tip. With such instruments it is possible to gain direct access to and thoroly treat these constricted areas in molars and occasionally in bicuspids.

It should not be understood that where there is too much tissue destruction in the crotch of these roots, or the position cannot be sufficiently exposed to permit the maintenance of proper hygiene, it is advisable to treat them. Many teeth are saved from destructive disease, however, by having instruments of this design with which to treat these otherwise inaccessible positions.

Exposed or Subgingival Tooth Structure

Whether the tooth structure is exposed or subgingival influences the thickness of blade and kind of plane.

The blade of an instrument used on exposed areas may be, and usually is, thicker than one intended to be passed underneath the gingiva for the obvious reason that there are no soft tissues to be considered and the deposits are often heavy and quite tenacious. These blades are usually concave and should be only heavy enough to withstand the pressure necessarily put upon them, which in extreme cases, rarely if ever, exceeds twenty pounds.

With the present-day manufacture of high-grade steel and improved instrument making, it is possible to construct an exceedingly delicate blade which will stand great stress; therefore these need be very little heavier, if any, than those intended for subgingival work.

It is permissible to use a plane on exposed surface instruments which comes off at right angles to the blade, tho one which bears the relation of an obtuse

angle can be made to work just as positively and possesses the added advantages of either pull or push motion and of being the actual end of the blade.

Blades designed for subgingival areas must not only be as thin and delicate as possible but have a face which is convex; the rule being to have the curvature of a blade follow closely the tooth form in the path of its plane. The plane should always be at an obtuse angle to the blade whether this be single or multiple, as in case of a file. In this way, the plane forms the actual end of the instrument, which not alone permits the removal of deposits with precision, but makes possible its extension into restricted areas to remove dead pericemental tissue which always precedes deposits. One great cause of protracted disease of these tissues is the failure to go beyond the deposits or deep enough to reach and remove all dead tissue which acts as a focus. It is manifestly impossible to reach this area in many cases with a working plane at right angles to the blade.

Excessive Gingivae

Excessive free gingivae are prolific sources of malhygiene and should receive minute attention. If, after thoro prophylaxis has been done, these tissues, which are often hypertrophied, do not re-establish the normal gingival crevice they should be deliberately resected. For this purpose small double-edged knives of suitable angles may be used to best advantage, provided that after resection the incised area be properly cauterized. With proper equipment and some experience, this much neglected part of surgical prophylaxis can be done easily, positively, and humanely. These instruments can be limited to three in number and may be called gingival resectors.

With these should be included a specially designed contra-angled tissue forceps to grasp and hold the gingiva while it is being removed, as such an instrument adds much to the positiveness with which this work can be done.

Embrasures

Embrasures are found so constricted at times that the soft tissues filling such spaces are either pinched to the extent of greatly diminished blood supply or protected from normal massage during mastication. If this restricted area is the result of malposition or caries, proper alignment or filling will correct the injury, but if the cause be worn or flattened contact points, it is permissible to so plane the embrasure angles that sufficient space and exposure will be gained to permit normal functioning of investment tissues. For this purpose three instruments are necessary; one straight triple angle contra-angle, with either cleoidal or cycle blade, for anteriors; the other two, right and left, are of the same general form but with each blade given off at a lateral angle sufficient to permit easy access to bicuspids and molars. Altho these should be designed for and known as embrasure instruments, they will be found to work admirably in the removal of heavy and tenacious deposits from the crown surfaces of all teeth.

Shank

The length and size of shank are important considerations in instrument design, as they each bear a definite relation to a positive working end. A short shank makes a more balanced instrument and one which permits better control, because its end is nearer the shaft and the grasp is therefore on the shaft instead of the shank.

The shank should be of good size to allow sufficient bulk of metal for grasp, if such ever becomes necessary, and large bearing surface when finger fulcrum is used.

Shaft

The shaft of an instrument for surgical prophylaxis demands special attion with respect to its size and form.

The size must be sufficient to permit a firm and delicate grasp. Firmness is essential to positive control and certain delicacy of touch, tho beyond a limited degree it is a hindrance to both. A shaft between 6 and 7 mm., or one-fourth inch in diameter, should be used, as a smaller one requires so much finger pressure in management that the digital sensory fibers are benumbed.

The form best suited to these instruments is the octagonal. This may be knurled or not, tho slight knurling adds a degree of positiveness to grasp not found in smooth-surfaced shafts.

Grasp

There are two grasps, the pen and the palm, used in surgical prophylaxis, and as both are permissible in certain positions, it is well to understand any advantage one offers over the other.

The pen grasp is generally used on account of the advantages it offers in facilitating approach and instrument movement, delicacy of touch, and ample power for most operations. The best form of this grasp should be cultivated and its application to each tooth position studied in order that a rapid and accurate technic may be developed. The position of operator, permitted by this grasp, is much less taxing, and therefore conducive to more and better work.

The palm grasp necessitates a suitable thumb rest, which limits its field of application practically to anterior positions. More force may be applied in the pull direction, but delicacy of touch is greatly reduced. For this reason it is rarely ever good technic to use this form of grasp for subgingival operations.

While this discussion is intended mainly as a plea for systematization and simplification of procedures incident to surgical prophylaxis, it is hoped the suggestions relative to basic instrument design may be of constructive value in the final determination of a standardized technic. The next great advance in preventive dentistry must be the unification of ideas, standardization of prophylactic requisites, and simplifications of procedures.

Discussion

Paul R. Stillman, New York City: Let me first compliment the essayist for the effort which he has made to set down in an orderly way the details of the instrumentation of denuded root surfaces. The subject is an extremely difficult one to present. Nevertheless we must praise a paper which has as its object the clearing up of the confused field of these technical procedures. This paper which Dr. Towner has presented exhibits the result of much study. By bringing to us his research upon the subject of the use of instruments he shows a desire to help us, and I have no doubt that periodontia has been benefited by his presentation of the subject.

Dr. Towner has, however, chosen a difficult subject for the reason that standardization is not practicable, except possibly for the size and shapes of instruments. Even in this field it is perhaps unwise to specify certain angles and widths of blade as standard, for the reason that general acceptance of this standard tends to discourage the adoption of changes which may actually be desirable.

But let us take up the points brought out in this essay. It is never a pleasant duty to disagree with those whom we admire. But I find it necessary to take issue with the title which he has chosen. The use of the term "surgical prophylaxis" is open to some objection. The substance of the paper makes it clear that it is Dr. Towner's intention to deal largely with the management of root surfaces from which the pericementum has been striped. The term "prophylaxis" means prevention. When the cementum becomes denuded the time for prophylaxis has passed. For even the measures which are required to preserve the state of health to which a diseased mouth has been restored savors more of the treatment of disease than of prevention, in the sense we wish the term prophylaxis to be used. The office of the periodontist is to restore diseased tissue to a state of health. But whenever tissue is lost from around the teeth, it is then a question of the preservation of health, not one of prophylaxis. We should not allow the consciousness of our ability to control dental periclasia to diminish the efforts of the entire profession for the prevention of these diseases.

I know that Dr. Towner does not mean to convey the idea which his title carries, and I desire to make a plea for a correct use of this word which is so frequently misapplied, if or no other reason than the psychological effect which such usage gives.

The question of standardization of surgical technic is one which involves a consideration of general principles and of their application. The general principles of a subject we recog-

nize as science, while their practical application is known as art. Jevons states: "A science teaches us to know, and an art to do, and all the more perfect sciences lead to the creation of corresponding useful arts." To design instruments for the surgical treatment of denuded cementum requires a knowledge of mechanical science. This same science governs the principles of their application to the tooth surface, with particular reference to the angle at which the blade meets the tooth surface in the performance of its function. This latter point, by the way, has not been mentioned by the essayist, but is extremely important in correct root surgery. The management of the instrument in the mouth is, however, an art. And it is here that standardization as attempted by our essayist becomes impracticable. To say that a certain instrument should be used on a certain part of a certain tooth would only be possible if teeth had always the same relative position, curvature of root, and depth of pocket. It is, however, desirable for the sake of the student to state as a general principle that those root surfaces which are the most accessible because of position in the mouth or inclination of the root axis are least treated with an instrument whose shank has a slight deviation from the axis of its handle. Also as the root surface becomes less accessible the angle of the shank to the axis of its handle should be increased.

For instruments of the hoe type the dimensions, shapes, and angles specified by the essayist represent an acceptable instrument. It should be specified, however, that the thickness of the shank at its outer extremity should be 0.4 mm., and that the depth of the hoe or working point should not be more than 0.4 mm. The purpose of these proposed dimensions is to prevent undue and injurious distention of the gingival tissue.

But the essayist has given no consideration to a different type of scaler, viz. the curette. This instrument has not as yet been standardized to the extent accomplished with the hoe scaler. It is therefore not possible to offer mathematical formulas for these instruments. But the experience of many years has demonstrated clearly that the curette not only is a valuable instrument but is practically indispensable in this field. Many operators find it easier to master the technic of the hoe-type instrument then that of the curette, nevertheless, neither this fact nor an acquired predilection for the former should be allowed to prevent the acquisition of an ability to use the latter. As a matter of fact the best results will undoubtedly be obtained by following an instrument of one type with that of the other. It should be remembered that the removal of deposits is only a part of root surgery. The cementum surface demands the most precise curettage. And it is surprising how frequently the one will reveal the operative shortcomings of the other despite the apparent assurance given by the first instrument used.

The essayist mentions the after-treatment of what he terms excessive gingivae, or hypertrophied gingival tissue, giving the impression that resection of such tissue is frequently required. Such practice is to be unhesitatingly condemned. When the etiology of hypertrophic gingivitis is understood in its entirety and treatment is directed toward the elimination of all the etiological factors, such resection is practically never needed. We must ever keep to the fore the importance of the gingival tissue as a protection for the underlying bone and pericementum. Its function in prophylaxis is therefore paramount. And the deliberate excision of this tissue should be a matter of last resort.

Dr. Towner also speaks of embrasures so constricted as to pinch the interdental soft tissues. He recommends the trimming of the tooth surface to restore the normal form of the approximal surfaces. I have for many years identified myself with the teaching of the remodeling of the tooth surface to conform to the anatomical necessities, and I have yet to see the occasion for the performance of this particular type of remodeling, nor can I conceive the case in which it would be indicated. When such a condition occurs, as is pictured by Dr. Towner, the only proper procedure is separation and restoration of lost contour by inlays. The reason is that as the teeth come into an abnormally close approximal relation, the proximity of the roots causes the chief interference with the circulation of the parts. To open up the embrasures when such a condition prevails may only increase the embarrassment of the gingival structure.

I regret to have found it necessary to disagree with Dr. Towner on some of his opinions. My remarks are not directed to his ear especially, but are called in the interests of an earnest desire to seek the truth. I again desire to commend him for his painstaking research on the subject of root surgery.

Jules J. Sarrazin, New Orleans, Louisiana: An effort at a task of unusual difficulty commands praise; and that is what Dr. Towner has done and what he deserves.

I do not think that a gentleman of his good judgment would expect any rapid stride in the direction of the adoption of standardized instruments and technic in tooth-neck scaling and root curetting, but he deserves credit for starting toward a goal which eventually must be reached, as surely as Dr. Black's excavators have been recognized as indisputably standard cutting instruments.

A wide gap must be bridged before a concensus of opinion based on experience may be had. To start with, there are those periodon-

tists who hold that all claim at simulating the action of a plane on roots is a delusion, and that, after all, it is a scraping process, no matter how we may call it, a curetting similar to that done on bone by the surgeon, but shallower. This in itself changes the desideratum from single-edged working blades to others capable of curetting in as many directions as possible while working on a root, not simultaneously, of course, but successively, with the same instrument, its access being slightly varied.

Again, in spite of the grouping in anteriors, bicuspids and molars, the acceptance of eight instruments to reach all surfaces and angles of one root in each group must necessarily result in a rather voluminous set, which could be avoided by the curetting plan where each instrument blade is made capable of work on one root surface and its two-line angles, and on adjoining surfaces in addition, by being sharpened on three edges instead of only one.

With suitable curves to shanks and necks, all necks carrying blades may be made long enough to require no additional instruments, for deep access, even in molar regions. The length of neck, for that purpose, which will bring the three working blades of the instrument slightly beyond the central long axis of the shank, is fully compensated by two metal knobs, 11 mm. in diameter, placed on slender handles, with their centers one at 23 mm., and the other at 51 mm. from the beginning of the handle. This also avoids weight by slender handles, and by the knobs being made of aluminum, if so desired.

A set of curettes capable of effectively reaching any part of any tooth neck, or root, or the bifurcations of lower, or the trifurcations of upper molars, may be reduced to a total of ten instruments on the curetting plan of three working edges to each point and the knobs mentioned to apply leverage at extremities.

I would expect some surprise from instruments such as described by Dr. Towner. I speak from experience. Quite a few years ago I procured his polishing files for the express purpose of trimming down the gingival protrusion of fillings which the other fellow had left to inevitably spoil the result of my curetting. His files did it beautifully, but they did other unexpected things. Ivory's catalogue said that those files were intended to smooth root surfaces after using Dr. Towner's scalers. I found out that they were invaluable for crushing hard extensive chunks of serumal calculus prior to curetting surfaces smoothly. I would therefore expect any other instruments designed by Dr. Towner to do much more than they were intended for.

The essayist is unquestionably right in angling working blades so as to allow their reach beyond deposits. Cemental pits, which have bathed in pus beyond them, harbor infection which will prevent healing by causing recurrent suppuration.

On the other hand, a Victor eye electrode of suitable design, backed by nerve blocking, will allow convenient removal by electric cautery, without any adjuncts, of all unadhered gingival flaps which might retain infection between themselves and tooth substance.

Dr. Towner clearly appreciates the importance of free blood circulation in septa between tooth necks, and that is to his credit because the local pathology which results from constriction there is but too frequently overlooked. Where such a condition is clinically present, the radiograph almost invariably shows that corresponding roots are in too close proximity to allow proper feeding, growth, and repair of cells by blood, lessening resistance to infection. If we trim at teeth necks, which is a doubtful task, apt to hopelessly lacerate "pinched" soft tissue, and leave a transverse concavity which becomes a disease trap, we miss the underlying too closely approximated roots. The whole trouble is caused by faulty dentistry much more frequently than in any other way, and the best remedy is, I believe, spacing and proper restoration which holds the space. Of course, Dr. Towner knows the difficulty in having such things thoroly done by our brother-dentists, and I would be glad to join him, in a way around it, if it could be applied successfully, as in the many other valuable suggestions he offers us in his excellent paper.

Dr. Towner: I appreciate the valuable criticisms and helpful suggestions made by both Dr. Stillman and Dr. Sarrazin. It was for the purpose of getting definite help in this most difficult problem that I suggested the selection of Drs. Stillman and Sarrazin to discuss the paper. They are deep thinkers and excellent workers, and usually make suggestions which are quite pertinent to any subject which is presented for their consideration.

I would like to say for Dr. Stillman's information that if he will read my paper again I think he will find I made reference to curettes, and that this reference was with respect to bifurcation curettes. The other instruments are planes and knives in principle.

With respect to the excessive gingivae, I wish to say that in my paper I tried to impress the fact that their resection should not be even considered until after every effort had been made to reduce them naturally. When ordinary prophylactic measures fail to reduce these tissues to normal condition, there is but one thing to do; that is to resect the excessive gingival flap, thus at once reducing the pocket and placing adjacent tooth structure in position to be kept clean by the patient. This is both simple and practical, as I see it, and is a very essential part of surgical prophylaxis.

CLASSIFICATION OF TEETH AS A GUIDING FACTOR IN THE CORRECT PREPARATION FOR PORCELAIN JACKET CROWNS

By HUGH AVARY, D.D.S., San Francisco, California

(Read before the National Dental Association, Boston, Massachusetts, August 23-27, 1920)

IT HAS been my observation that of the many papers written about the merits of porcelain jacket crowns, blending of colors, etc., very little has been said about the preparation of the teeth. It has been suggested to cut the teeth to a cone-shaped nub, and cut shoulder around root below gum line. Make copper band, take impression with modeling compound, take wax bite, note shade, and mail same to the laboratory. Many of you are familiar with these instructions. A very able clinician has favored stripping off the enamel with special scalers. This method should be used only in cases where the tooth is in normal alignment, that is, class No. 1.

There should be a standardized technic for the preparation of teeth for porcelain jacket crowns, as there is a Black technic for cavity preparation, and as there is an angle classification in orthodontia. If there were a concise technic for preparing any tooth for jacket crown work more dentists would take up this important branch of our modern operative dentistry, and with the confidence that goes with knowing how, more ideal results would be had.

I occasionally meet a dentist who tells me that the death of the pulp often occurs after he makes a jacket crown for a patient. I have in nearly all these cases been able to analyze that technic—the tooth was indiscriminately cut down to a cone-shaped nub, or it was not properly protected after the preparation until the jacket could be finished and cemented on, or the tooth was not tested for vitality before operating. I believe there is no pulp trouble, taking for granted the tooth was vital before the preparation, if the technic for the preparation is correctly used. I have accordingly divided the teeth into four classes to simplify their correct preparation, as follows: (1) teeth in normal alignment; (2) teeth that are rotated; (3) teeth that are either labial or lingual to normal; (4) teeth where it is advisable to open the bite.

First radiograph the tooth to ascertain the proximity of the horns of the pulp, the length of the root, and the condition of the alveolus around the root; also test to make sure the tooth is vital. Take an accurate impression of the tooth and include several teeth on either side to make a study model; then study the contour and characteristics of that patient's teeth regarding size, color, and alignment. If the tooth to be jacketed is not in class No. 1, that is, if it is not in normal alignment, determine about how much it may be corrected by jacketing. Note which class it belongs in and prepare accordingly. Bear in mind that the alignment of the finished jacket is largely determined by the way in which the labial surface of the tooth is prepared. For instance, if the tooth is in class No. 2 or 3, and is still labial to

normal after the preparation is finished, it will be impossible to have the jacket in normal alignment when completed. The guiding factor in the finished jacket is the correct preparation of the tooth; otherwise the result will not be ideal.

In a general way the prepared tooth should look like a small reproduction of the tooth, having the characteristic outline of the tooth itself. A correctly prepared cuspid should have outlines like a cuspid and not like a central, as is so often the case. An inferior bicuspid should have the outline of an inferior bicuspid, the buccal cusp more prominent, not like a superior, for when it is incorrectly prepared and the buccal cusp is cut too short there is danger of cutting too close to the horns of the pulp or across the recessional lines of the pulp.

Again, a preparation in which the shoulder is over 1mm. or less than ½ mm. is not correct. Unless in an extremely small lower incisor or peg-lateral, less than ½ mm. is not sufficient for strength; or if the finished jacket is as thin as paper, as you have no doubt seen displayed and have admired at clinics, the cement will show thru when the jacket is set. If the cuspid is prepared on the incisal edge, central, the cement will show thru.

Class No. 1.—Shorten tooth from 1 to 2 mm. according to the length of the tooth and the bite, with a large wheel stone. Next cut the approximate sides, starting in about 1 mm. from the approximate surface so that when it is cut down to the gingivae there is a shoulder cut; in other words begin to cut in about 1 mm. so that the shoulder is always ahead of the stone; cut with thin Miller separating disks or Joe Dandy stones. Then cut lines thru the enamel on the labial surface with the same thin stone, first cutting longitudinal lines thru the enamel about the depth you have predetermined from the study model. Begin to cut the mesio-distal lines at the gingival margin and cut about same depth (not over 1 mm. as a rule.) The surface is then divided into small enamel blocks which may be chiseled off; grind them off with small wheel stone; then with an inverted cone stone cut into the tooth at the gingivae, to the desired depth, starting at the shoulder; carry labial shoulder under gingivae with end-cutting burs and Miller stones No. 340 ½ in R. A. or contra-angle H. P. The labial incisal edge is ground until there is room for the porcelain to cover it. Tone up the surface with finishing burs and stones; this surface should be slightly convex. The lingual is the last to be prepared. Note the bite and the characteristics of the development lines, grooves, etc., of this surface. With an inverted cone stone cut thru the enamel just short of the gingivae, then drag the stone across mesial to distal and cut thru the enamel; cut the shoulder under the gingivae, using end-cutting burs and No. 340 ½ Miller stones as used on the labial side. The shoulder should then be cut all around the tooth. Next cut away sharp angles, if any, at the mesio-distal angles of the tooth, and tone up shoulder so that it is uniform, not less than ½ nor more than 1 mm. The tooth may then be polished with cuttlefish disks and the shoulder may be planed with Black cutting instruments No. 53 or 54. The preparation is then carefully washed off, dried with alcohol and painted with rosin chloroform varnish which should be dried with hot-air syringe. This is important as it prevents the dentin from absorbing secretions, etc., lessens thermal shock, and prevents the irritation of the pulp by any acids that may be liberated by the cement. The tooth is carefully covered with a gutta-percha jacket made on the tooth, using Gilbert's temporary stopping. Never put on a silicate temporary jacket, as advocated by some manufactures for there is apt to be an irritated pulp and gingivae. The quicker the jacket is finished the less danger to the pulp from careless protection during the making of the jacket.

Class No. 2.—The preparation is the same as for No. 1 for the incisal edge and approximate sides. The labial is cut more on the angle that is too prominent labially and very little from the other angle; by using care it is often possible to cut off enough to correct the rotation to a marked degree if not to entirely correct it. In these rotated cases the shoulder is sometimes necessarily thinner on the less prominent angles, but that does not matter in these types as the bite is lessened on the angle. The lingual is reduced the same as the labial. Then finish the shoulder in the same manner as for No. 1.

Class No. 3.—The approximal and incisal are the same as for No. 1. The labial surface is as indicated, using care to cut off as much as possible. In adults more can safely be cut away and the protrusion corrected to a great extent. Very little should be cut at the lingual incisal angle, and the shoulder should be cut in deeper than No. 1. In those teeth that are lingual to normal and adjacent teeth not crowned the labial shoulder is cut thin, about ½ mm., and extended further under the gingivae, as the labial is baked thicker. By gradually building out the convex surface at the gingivae the finished jacket is deceptive at a glance appearing to be on a root having normal alignment. The lingual incisal angle is cut away as much as possible and shortened more than No. 1. This allows the cutting edge of the jacket to be correctly aligned without being clumsy and bulky, which would result if no definite technic were used.

Class No. 4.—I have several cases in which there is a marked abrasion, the tooth being almost devoid of enamel and having the appearance of excessive wear. These patients usually suffer too much from closed bite, accompanied by compressed lips and deepened lines around the mouth. These cases usually have end to end bite, and the patient suffers from thermal shock, and is annoyed by sweets and acids, such as the juice of grape fruit or oranges. Where the pulp has not been involved, the only practical thing to do is open the bite of the anterior teeth and bicuspids with jacket crowns; the incisors are prepared as in No. 1, except where possible the incisal edge is cut so there is slight depression or groove mesio-distally. This greatly reduces the stress as the inclined planes prevent all the stress from being at the shoulder. The shoulder is carried deeper under the gingivae to secure more frictional retention.

To summarize preparations: The labial should be slightly convex, the lingual concave. Approximal slightly tapered from gingivae to axial edge. The shoulder cut at right angles to long axes of tooth and cut square-edged, not beveled. The posteriors should follow the outline of the enamel, bicuspids should have depression running mesio-distally but *not* bucco-lingually, as has been advocated by some, for there will frequently be pulp trouble if groove is cut in this way because the stress in masticating on posterior teeth is greater bucco-lingually; the contact points will take care of any mesio-distal stress. The tooth form should be reproduced as accurately as possible, for nature designed the forms of teeth so as to discharge certain functions, namely to be efficient masticating surfaces and to protect the investing tissues. It cannot be too strongly emphasized that unless the tooth form is correctly restored the gum may recede in a year or two. The poor tooth form allows the bolus of food to be forced against the gingivae instead of deflecting the food as nature intended. Restore contact points as indicated in that particular case.

To drive home the thought that jacket crowns properly made are one of the most ideal methods of restoring tooth form from an aesthetic as well as a dental standpoint I have revised the old saying, "Self-preservation is the first law of nature" into "Pulp preservation is the first law of dentistry."

THE ANATOMY AND PHYSICS OF THE TEMPORO-MANDIBULAR JOINT

By GEORGE H. WILSON, D.D.S., Cleveland, Ohio

(Read before the National Society of Denture Prosthetists, Boston, Massachusetts, August 20, 1920)

HAVING been invited to continue the study and discussion of the anatomy and physics associated with denture construction the following is presented for consideration.

A résumé of the paper presented last year[1] is necessary for a further study of the subject. The paper presented a short description of the muscles and ligaments involved in mastication, as stated in the 20th edition of Gray's *Anatomy;* and from it, deductions were presented of the functions of the involved tissues as comprehended at that time. Further study has confirmed the major conclusions, but some of the minor statements were erroneous. The motive of this paper is to present a revision of the paper of last year, consider the remaining factors of Dr. Bonwill's teaching, and to suggest a line of study for the practically applied fundamental principles of mastication in artificial denture construction.

The muscles named for the opening movements of the mouth were: platisma, digastricus, mylohyoideus and geniohyoideus. Of these muscles Wm. Wright, an English anthropologist, states that in a primitive form of vertebrate (dog fish) the geniohyoid is the only muscle that acts to open the mouth. The second muscle added in the ascending developmental scale is the mylohyoid and the third is the digastricus. This would imply that the platisma belongs only to the highest forms of vertebrate. The muscles for closing the mouth were named as—masseter, temporalis, pterygoideus externus, and Pterygoideus internus. Of these eight muscles only one needs further consideration.

The pterygoideus externus is classed as a muscle for closing the mouth and especially for the lateral girations of the mandible. It should also be classed with the muscles for opening the mouth. This muscle is inserted into the neck of the condyle and into the articular cartilage. The function of this muscle in the opening movement, when acting in conjunction with its mate, is to draw the head of the condyle and articular cartilage forward on to the articular eminence; thus placing the head of the condyle in position for prehension and incision. Gray (p. 387) calls attention to this action of the pterygoideus externus. In the closing movement of the mandible ths muscle, on the triturating side of the mouth, becomes fixed; but the pterygoideus externus of the opposite side of the mouth in conjunction with its associate internus, and possibly the masseter of the work side, produces the lateral mandibular movement as described by Bennett. This movement of the mandible explains the chief function of the cuspid teeth in modern man. They are the important tactile and guiding teeth and when the teeth are lost the tactile sense is impaired and the

[1]Jour. Nat. Dental Asso., May, 1920, p. 414.

patient has little or no control of the movements of the mandible. The tactile sense is not in the teeth themselves, but in the peridental membrane; however, it acts thru the teeth. With the insertion of artificial dentures the mucous membrane of the alveolar process has to be educated for this function. The sense is conveyed thru the artificial dentures which function just as a stick in the hand of a blind man. This interpretation of the function of the pterygoideus externus gives a more reasonable explanation of the forward excursion of the head of the condyle than was presented in the former paper. In that paper the forward excursion of the head of the condyle in the opening movement of the mould was attributed to the temporomandibular ligament acting as a fulcrum over the neck of the condyle, thereby causing the head of the condyle to travel forward on to the articular eminence. William Wright, previously referred to, suggested this pivotal action of the temporomandibular ligament (1913); however, there is no evidence that this interpretation has had a wide acceptance. It has been accepted by a few writers only and the evidence is entirely against the theory. Necessarily if the head of the condyle was carried forward in the opening movement of the mouth by the stress of this ligament, the same stress would tend to cause the head of the condyle to return to its normal rest position upon the closing movements. Whereas, the forward excursion of the condyle is a positive movement in prehension, and remains in prehension until guided backward by the inclined planes of the teeth. This forward movement of the condyle is rationally explained by the action of the pterygoideus externus, and hence the temporomandibular ligament is unnecessary for this function.

It is quite probable that too much stress has been placed upon the sphenomandibular and stylomandibular ligaments acting as the fulcrum for the opening movements of the mouth. The idea of fulcri conveys to the mind the impression of fixed rotation centers, which do not exist in the mandibular movements. The mandible is suspended and all of its movements are of a gliding nature rather than from fixed rotation centers. The spheno and stylomandibular ligaments are used to designate the locality of the swinging rotation center of the opening movement of the mandible. However, this location can be better described by the phrase "axis of rotation in the proximity of the mandibular foramina" (Gray), and thus not convey an exaggerated idea of the importance of these ligaments. Anatomists describe the ligaments spheno and stylo as thickened portions of the fascia colli (deep cervical fascia); and it is a fact that these ligaments can be developed or eradicated, by methods of dissection, *according to the preconceived opinion of the dissector.* This last statement is also true of the temporomandibular (external oblique) ligament. The writer wishes to express his appreciation to Professor Prentiss for his careful investigations of the temporomandibular joint and its component tissues. A day spent at the University of Iowa last winter thoroly convinced the writer of the correctness of the investigations. It is true that the text books and artificially prepared specimens show these ligaments in a highly developed condition, but they should be classed with the fallacies of science that have been honored because of their hoariness.

The capsular ligament of the temporomandibular joint is a lax ligament, designed to confine but at the same time *to permit freedom of movement in any direction.* The medical profession had no motive in a detailed study of this joint until the importance of the dental specialty was established; hence the erroneous ideas were perpetuated until Professor Prentiss, an investigator and also a teacher of dental students, became interested.

This elimination of these ligaments as fixed rotation centers does not in any way weaken the proposition that the mandible is not a lever of the third class; but it confirms the fact of the masticatory apparatus being a mill and that the muscle action is entirely expended in work and not wasted upon a fulcrum.

With this revision of the paper of last year the second part of this contribution consists of a study of the remaining factors of the anatomy and physics of denture construction.

The late Dr. Bonwill can justly be called the father of the science of denture construction (science=classified knowledge) and the followers of Dr. Bonwill as the Bonwill School. The science of dental prosthetics as taught by Dr. Bonwill can be grouped under five headings, namely:

1st. The mandible is a lever of the third class.

2nd. The mandible is an equilateral triangle.

3rd. The mandibular movements are from fixed rotation centers.

4th. The alignment of the teeth.

5th. The dental circle.

The first three headings are hypotheses and hence are open for investigation.

As regards hypothesis No. 1 it seems to the writer that the parallelogram of forces as applied to the muscles, the destruction of the articular tissues with the loss of the posterior teeth, as demonstrated by Professor Prentiss, and the wanton waste of energy, if the lever theory were true, *proves conclusively that the function of the mandible is not fundamentally a lever.*

So far as known to the writer the correctness of the second hypothesis was first questioned by Professor F. W. Frahm, which he demonstrated from studies of crania while associated with the University of Colorado, published in the *Dental Cosmos* of May, 1914. He demonstrated that the condyles were not necessarily equidistant from the sagittal plane and therefore did not describe an equilateral triangle.

In April of the same year the writer measured 300 mandibles at the Smithsonian Institution, of which only 6% described a Bonwill equilateral triangle. Of the remainder, 64% of the 300 described isosceles and 30% scalene triangles.

A study of the cephalic index proves conclusively, to the mind of the writer, that the Bonwill equilateral triangle is not the intent of nature. Nor can it justly be claimed that the Bonwill theory of an equilateral triangle is the ideal of the highest developed crania, altho with some races of mankind it may be considered as the type, at least a type. To study the cephalic index it may be well to define certain anthropological terms.

Glabello-occipital line: This line is from the median point of the superciliary ridges (glabellum) to the farthest median point of the occiput. The vertical plane described by this line is known as the glabello-occipital, also as the sagittal, and also as the median plane.

Index (plural=indexes or indices) is defined as a comparison of two measurements that are supposed to have a relation to each other. The index formula is stated as: The usually long line is to the short line as 100% is to the required per cent of index. Therefore the cephalic index is the width of the skull multiplied by 100 and divided by the glabello-occipital measurement.

Two classifications of the cephalic indexes should be explained. In one the crania are classed as long and narrow—dolichocephalic with an index of less than 80; and as short and wide—brachycephalic, with an index of 80 or more. The other classification is long, medium and short. The long and narrow head is dolichocephalic with an index under 75; the medium is named mesaticephalic and the index is 75 and up to 80; and the short is brachycephalic with an index of 80 or above. Preference is given to the second classification.

It is self-evident that the mandible will conform to the type of the cranium, also that it will be modified by orthognathism and prognathism.

The mandibular index is defined as: The projection length compared with the bicondylar diameter. That is, projection is to width as 100 is to index.

Bonwill's equilateral triangle of the mandible is defined as: The triangle formed from the crest of the condyles and the mesial incisal angle of the central incisors. Therefore, the mandibular index and the Bonwill triangle should not be confused as they are entirely different measurements, altho similar.

Dr. Bonwill considered that the average triangle was just four (4) inches on each side, but that there was a variation of an inch in size.

The writer has in his possession four skulls, the measurements of which will very well illustrate the errors in the Bonwill theory of the equilateral triangle. Skull No. 1.—European, low mesaticephalic; cephalic index 75.26. The mandibular index is 100, that is, the extreme width from condyle to condyle and the projections are equal, 113 mm. The Bonwill triangle is a perfect four inch equilateral. Notice—the skull is low medium width and orthognathus. Skull No. 2.—European, high brachycephalic, cephalic index 89.47. The mandibular index 111.5, that is, the bicondylar measurement is 126 mm. and the projection is only 113 mm. The Bonwill triangle is isosceles with a base of 4¼ inches and the sides of 4 inches each. Notice—the skull is wide and orthognathus, and has a wide jaw in harmony with the cephalic index and orthognathism. Skull No. 3.—Malay male, low mesaticephalic, cephalic index 76.5. The mandibular index 95.12, that is, the bicondylar measurement is 118 mm. and the projection is 123 mm. and the jaws are prognathus. The Bonwill triangle is scalene—the base 4 inches, the right side 4¼ inches, and the left side 4⅜ inches. This skull has all of the teeth in place and apparently typical occlusion. Notice—the cephalic index is slightly greater than No. 1, but the mandibular index is nearly five points less because of the prognathism. Skull No. 4.—Malay female, low mesaticephalic, cephalic index 75.16. The mandibular index is 93.63, that is, the bicondylar measurement is 103 mm. and the projection is 110 mm. The Bonwill triangle is isosceles and has a base line of 3½ inches with side lines of 4 inches. Notice—that while the cephalic index is only .1 of a point less than skull No. 1, that there are 6.37 points difference in the mandibular indexes, due to prognathism.

These four skulls show that there is a relationship between the cephalic and mandibular indexes; however, the mandibular index is also influenced by orthoprognathism.

It is instructive to consider the cephalic index from the earliest times. A most helpful volume for this purpose is a book on "The Ancient Races of the Thebaid," by Thompson and Randall-MacIver, and published by the Clarendon Press, Oxford, 1905. This work consists of investigations and measurements of more than 1500 Egyptian skulls. Of these skulls 378 were classed as predynastic and this period is placed as ending 4800 years before Christ. Of these 387 skulls, 71½% were dolichocephalic, 26¼% were mesaticephalic, 2¼% were brachycephalic. Of the 100 skulls attributed to the Roman period 46% were dolichocephalic, 41% were mesaticephalic and 13% were brachycephalic. In the Eighteenth Dynasty only was there a period between the earliest known time and the Roman conquest when the percentage of the mesaticephalic surpassed the percentage of dolichocephalic. The Eighteenth Dynasty was represented by 205 skulls. Indexes 71, 72 and 73 prevailed during the predynastic

and early dynastic. As the Egyptian people were not a pure race, but were a mixture of negroid and non-negroid races, they prove conclusively that the Bonwill equilateral triangle was not the intent of nature.

Comparative anatomy teaches us that nature did not associate the equilateral triangle with great power, but almost universally the powerful jaws were associated with a short bicondyle measurement as compared with the long and often excessive projection, as instanced by the crocodile and Carnivora in general. That intelligence is not necessarily preeminent in a broad head is suggested by the heads of a bull-dog and Scotch collie.

The conclusion of this phase of the subject is that an equilateral triangle was not nature's ideal, and that the incorporation of the theory into dentistry only added mysticism and confusion to illy understood denture construction.

The third hypothesis of Dr. Bonwill was a logical deduction based upon false premises. Dr. Bonwill accepted the prevailing idea that the mandible functions as a lever of the third class. The writer does not know that this attributed function of the mandible was ever questioned until lately, and he does not know with whom it originated, for it seems to have been conceived of in several countries at about the same time. Dr. Bonwill was obsessed with the idea of an equilateral triangle; and as the theory of fixed rotation centers upon the head of the condyles was based upon two false premises the theory could only by chance be true.

Professor Gysi demonstrated that certain of the rotation centers of the mandible, by actual measurements of the condylar movements, were "anywhere in a sphere one inch in diameter, and situated back of the condyles and about the sagittal plane." Mr. Norman G. Bennett, of England, demonstrated the lateral mandibular movement from a center located in the sagittal plane and at the culmination of the long axes of the upper teeth. The previous work of Count Spee demonstrated that the occlusal surfaces of the lower teeth were upon the segment of a sphere with its center at the same point as the Bennett oscillating center. Spee's and Bennett's work confirm each other. These investigations of Count Spee, Professor Gysi, Mr. Bennett, and others prove conclusively that the third hypothesis of the Bonwill School was based upon false premises and is erroneous.

The two remaining tenets of the Bonwill School were well made expressions of careful observations of the alignment and occlusion of the teeth of man.

It must be apparent to all that a new school of dental prosthetics is forming, and it is a logical deduction that only the proven truths of the Bonwill School can be retained in the new school and the discredited theories only as historical data. Therefore, as the three fundamental principles of the Bonwill School are proven erroneous they cannot in any way be used in the new school. This will necessitate a radical change in denture nomenclature. Illustration: It will not be consistent to speak of an anatomical antagonizer as being constructed upon the Bonwill equilateral triangle; or to say that the casts and occlusion models are mounted in the antagonizer to the Bonwill equilateral triangle; but, that the instrument is constructed for a medium mandibular index, and that the case is set in the investment to a medium mandibular index. The new nomenclature, whatever it may be, may not be as euphonius or of such reverent memory as that of the passing school; but the future dental profession will only revere and honor the present generation for the truth, wisdom and superior technic bequeathed to them.

It seems to the writer that the first duty of the National Society of Denture Prosthetists is to approve or disprove

and disapprove of the evidence presented in this paper; for if the arguments of this paper are well made all of the three basic principles of the Bonwill School are destroyed; and a nomenclature and technic of denture prosthetics should be elaborated for the new school.

The remaining portion of this paper is offered as suggestions for the new school for denture construction and teaching.

1st suggestion. Denture construction and teaching of the new school should be founded upon the most modern approved knowledge of anatomy, physics and aesthetics. The gross anatomy and histology of both the hard and soft tissues, both in the typical and anomalous forms should be carefully studied. Especial attention should be given to the metamorphosis resulting from the loss of the dental organs. Especially should attention be given to the results of alveolectomy.

At other times the writer has called attention to the importance of the base-plane upon which a denture rests, and that the bearing of an artificial denture must be equal to or a little greater upon the periphery of a base-plane than upon any inclosed circumscribed area. When the importance of the base-plane and peripheral bearing of the base-plate are comprehended, as they will be with a more detailed study of the gross and metamorphic anatomy of the tissues associated in artificial denture service, the jingle of "muscle trimming" associated with the Greene-Supplee impression methods will not be so carelessly used as at present. Peripheral bearing can be destroyed by improperly applied muscle trimming.

William Wright stated that the anterior portion of the temporalis muscle and the pterygoideus externus were innervated by the same branch of the trigeminal nerve. This implies that the anterior portion of the temporalis and pterygoideus externus act in conjunction with each other. The parallelogram of forces applied to these two muscles will demonstrate the prehensile action of the mandible. This suggests that a detailed study of the innervation of the masticatory muscles may be very fruitful of results.

2nd suggestion. Prosthetic apparatus. There are two pieces of apparatus that because they are associated with so wide a scope of dental education require very careful study. They are the articulator (a better name is the antagonizer), and the vulcanizer.

The antagonizer is essentially the instrument of applied anatomy and physics. The instruments especially adopted to the Bonwill theories were unnecessarily complicated because they were constructed upon the long opening movements of the mouth while the instruments adopted to the new school need only be adopted to the closing movements of the mouth and this ordinarily for about 4 mm. in the anterior posterior direction, and about 2 mm. in the lateral movement of the mouth. This does not imply that the instruments that were adopted for the Bonwill theories cannot be used in the new school, for they certainly did efficient work in denture construction and can still do so in the more simplified requirements of the new school. The difference between the requirements of the two schools is in the mental comprehension of the demands of nature and the more simple and convenient way for producing the best results.

I cannot close this paper without giving some expression of appreciation to Dr. Rupert E. Hall for his laborious part in making practical and new and cumulative ideas of denture prosthetics. However, he should demonstrate the merits of this instrument upon other than the exploded Bonwill theories.

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Editorial Department

THE MEETING OF THE AMERICAN INSTITUTE OF DENTAL TEACHERS AND ITS SIGNIFICANCE

The Indianapolis meeting of the American Institute of Dental Teachers is now a retrospect. We look back to fix in mind its scenes, its personalities, its discussions. Old friends greeted each other mellowly and new acquaintances were made with warmth. The democracy of the meeting was, as it always is, a delight. Old topics and new came to the fore, the former draped with the fashions that another year had created and the latter with the enthusiasm that newness always

demands. Judgment passed upon the meeting *in toto* would be that it had met its purpose—was a success.

True to that purpose, classroom problems and teaching methods, with here and there a question of administration, formed the nuclei of interest. Papers were read on the most vital concerns of dental school well-being and prosperity. Experiments in popular education were detailed and means for the training of teachers of dentistry were advanced. Pragmatism and idealism exchanged turns in the forum. The past was reviewed, the present depicted, and the future outlined according to varying hopes.

The future has always dangled the pot of gold. The big issue that filled to crowding the general discussions was the lengthened dental course, or better spoken, the added pre-dental year with the close possibility of an added pre-dental two years. The fusion of the dental and medical courses, with dentistry as a specialty of medicine, was discussed as an inevitable occurrence. Dentistry was defined potentially and positively as a specialty of medicine soon to be realized. No specious argument, no misdirected witticism, no grandiose "thus far shalt thou go" can stop the tide-like tendency of dental education. Dental educators read and understand the lettering of prophecy, and dentistry alienated from medicine will be, must be as impossible as the separation of the mouth from the rest of the body. "The scenes are shifting in the great theater of the world" and a separatist profession is being asked by what right it exists in isolation.

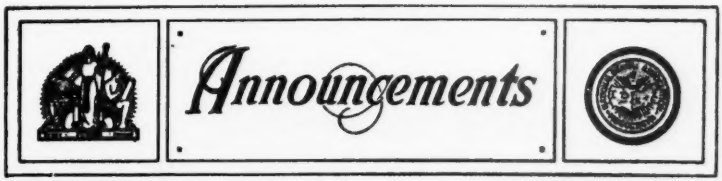
Listening, one could not help wondering why the gods have writ that history should repeat itself. With a little transposition one can find a similar tale of long and often ardent argument on just such problems in the history of education. The struggle between a demand of evolving times and interests imbedded in tradition or commercialism or ignorance is old and its manifestations are always strangely similar. One recognizes old faces and forms in almost every turn of the discussion and a wonder arises sometimes why the argument has to be repeated. Forty years ago Huxley was arguing for a place in the curriculum for science and for the right to existence of the scientific school. Fifteen years ago all the problems that could attend the emancipation of schools from the thraldom of commercialism were torturing medicine. Pedagogy has been a part of well-established curricula for many years and pedagogy is pedagogy in its fundamentals. Perhaps the constitution of man calls for repetition. Perhaps the education of the constituency calls for repeated statements of the old positions. It is certain that the issues were twice-told tales.

Again the onlooker could not mistake the fact that these men bore a great responsibility. Definition of the relation of the school to the profession is as unnecessary as an argument for the need of food to life. History has it that every essential to human advancement has at times been prostituted and exploited. Coin of the realm is evaluated by the counterfeit. Somewhere in the mixture of good and bad, of worth and dross, are always to be found those who would pilot the real to recognition and influence. Those present at that meeting recognized their responsibility, the fact that dentistry, as yet but partially defined, marked time or advanced, bore its banner with pride or trailed it, as they decreed.

It was this that called to attention a deep undercurrent of devotion to a great cause. It moved some who spoke, it stirred many who listened. They were present who recognized in dentistry a cause worthy of toil and weariness, of calumny and heartache, of the fullest measure of service. They made one feel that they bore on heart and conscience a great responsibility that they measured fully the task set before the colleges of dentistry in America, that they esteemed the schools in terms of heart and brain, soul and center of what we term our profession and so could not serve them too well.

ADMIRAL STITT SURGEON-GENERAL OF THE NAVY

Rear-Admiral E. R. Stitt, at present director of the United States Naval Medical School, has been appointed Surgeon-General of the Navy, succeeding Rear-Admiral Braisted, who is retiring in conformity with his own urgent request. The acceptability of the appointment should make certain its ratification by the Senate. For thirty-one years, Admiral Stitt has given himself wholly to the service whose uniform he wears. He is perhaps personally known to ninety-nine out of a hundred men in the Naval Medical Corps. He is also well known to the physicians of the country as an educator, as a man of remarkable attainments in laboratory research, as the author of several standard medical textbooks, and as an inspiring leader in medical science. In the Navy he has held appointments representing the service on many general committees and boards. He has cooperated frequently with other government departments and with scientists in civil life. In a word, he is peculiarly adapted for the high office to which he is now appointed. He may be assured of the full support of the medical profession of the country in any work which he may undertake for the development and the advancement of science in the Medical Corps of the Navy. Meanwhile Rear-Admiral Braisted steps out of the position of Surgeon-General with an excellent record for faithful service and good work. He was at the head of the Bureau of Medicine and Surgery of the United States Navy during the ordeals and trials of the Great War, in which the Navy took no small part. His bureau came thru with honor and credit and with the good will of the physicians who served during the war.—*Journal American Medical Association, December 4, 1920.*



CALENDAR OF MEETINGS

NATIONAL SOCIETIES

National Dental Association, at Milwaukee, Wisconsin, August 15-19.

National Society of Denture Prosthetists, at Milwaukee, Wisconsin, August 1-13, Hotel Medford.

Psi Omega Fraternity, Biennial Grand Chapter, August 10, and National Alumni Chapter, August 15, at Milwaukee, Wisconsin Hotel. M. M. Printz, Supreme Councillor, 25 East Washington Street, Chicago, Ill.

Xi Psi Phi Fraternity, Alumni Association, August 15, at Milwaukee, Wisconsin Hotel. J. Emmett Northcutt, Secretary, St. John and Elmwood Avenue, Kansas City, Mo.

Delta Sigma Delta Fraternity, August 15, at Milwaukee, Hotel Pfister. R. Hamill D. Swing, Supreme Scribe, 1623 Walnut Street, Philadelphia, Pa.

American Dental Library and Museum Association, August 15 and 17, at Milwaukee. B. W. Weinberger, Secretary, 40 E. Forty-first Street, New York City.

American Society of Orthodontists, April 27-30, at Atlantic City, N. J., at Hotel Ambassador. Ralph Waldron, Secretary, 549 High Street, Newark, N. J.

American Institute of Dental Teachers, third week of January, 1922, at Montreal, Quebec. Abram Hoffman, Secretary, 381 Linwood Avenue, Buffalo, N. Y.

STATE SOCIETIES

March

Kansas, at Wichita (21-26).

Oklahoma, at Oklahoma City (14-19).

South Dakota, at Sioux Falls (March 28 to April 2).

Vermont, at Rutland (16, 17, 18).

April

Alabama, at Montgomery (12, 13, 14).

Connecticut, at Waterbury (21, 22, 23).

Kentucky, at Louisville (13, 14, 15).

Michigan, at Detroit (11-16).

Mississippi, at Jackson (15-19).

Missouri, at Springfield (25, 26, 27).

West Virginia, at Bluefield (11, 12, 13).

May

Arkansas, at Little Rock (no date given).

Illinois, at Peoria (10, 11, 12).

Indiana, at Indianapolis (16, 17, 18, 19).

Iowa, at Des Moines (3, 4, 5).

Massachusetts, at Boston (4, 5, 6).

Maryland, at Baltimore (25, 26, 27).

Montana, at Billings (16-21).

Nebraska, at Omaha (16, 17, 18, 19).

New York, at New York City (11, 12, 13, 14).

North Dakota, at Minot (no date given).

Pennsylvania, at Philadelphia (3, 4, 5).

Tennessee, at Nashville (17, 18, 19, 20).

June

California, at San Francisco (June 27 to July 2).

California (Southern) at Los Angeles (no date given).

Florida, at Gainesville (no date given).

Georgia, at Macon (8, 9, 10).

Maine, at Bar Harbor (21, 22, 23).

New Jersey, at Atlantic City, Steel Pier (1, 2, 3),

New Mexico, at Albuquerque (no date given).

North Carolina, at Charlotte (23, 24, 25).

South Carolina, at Greenville (no date given).

Utah, at Salt Lake City (21, 22, 23).

July

Washington, at Vancouver, B. C.

December

Ohio, at Columbus (6, 7, 8).

MEETINGS OF STATE BOARDS OF DENTAL EXAMINERS

Alabama, at Birmingham, Birmingham Dental College, Avenue F and Twentieth Street, June 20. H. Clay Hassell, Secretary-Treasurer, 616 Twenty-second avenue, Tuscaloosa.

Connecticut, at Hartford, June 23, 24, 25. Robert W. Strang, Recorder, 886 Maine Street, Bridgeport.

Delaware, at Wilmington, Municipal Building, Tenth and King Streets, January 12 and 13. W. S. P. Combs, Secretary, Middletown.

Idaho, July 12. Paul Davis, Director, Bureau of License, Boise.

Iowa, at Iowa City, College of Dentistry, February 6. C. B. Miller, Secretary, 726 Fleming Building, Des Moines.

Kansas, at Wichita, June 13. G. F. Ambrose, Secretary, 111½ S. Main Street, Eldorado.

Massachusetts, at Boston, Harvard Dental College, Longwood Avenue, March 14, 15, 16, 17. J. N. Carriere, Secretary, 352 Main Street, Fitchburg.

Maine, at Augusta, State House, July 7, 8, 9. Henry Gilman, Secretary, 192 State Street, Portland.

Mississippi, at Jackson, Senate Chamber of the State Capitol Building, June 21. Burt J. Marshall, Secretary, Marks, Miss.

New Jersey, at Trenton, Second Regiment Armory, June 27-July 1. John C. Forsyth, Secretary, 429 E. State Street, Trenton.

New Mexico, at Albuquerque, February 7. M. J. Moran, Secretary, Deming.

North Carolina, at Charlotte, June 18. F. L. Hunt, Secretary, Asheville.

Vermont, at Montpelier, State House, June 27, 28, 29. Harry F. Hamilton, Secretary, Newport.

INDIANA STATE DENTAL ASSOCIATION

The next annual meeting of the Indiana State Dental Association will be held at the Claypool Hotel, at Indianapolis, Indiana, May 16, 17, 18, 19, 1921. O. A. VanKirk, of Kendallville, Indiana, is in charge of the exhibits. There wil be an unusual fine program for the entire four days. A cordial invitation is extended to all members of the National Dental Association. For further information address

A. J. KIMM, *Secretary*
704-5 Citizens Bank Bldg., Evansville, Ind.

DELTA SIGMA DELTA FRATERNITY

The annual meeting of Delta Sigma Delta Fraternity will be held in Milwaukee, on Monday, August 15, 1921, at 10:00 A. M. The headquarters will be the Hotel Pfister.

R. HAMILL D. SWING, *Supreme Scribe*
1623 Walnut St., Philadelphia, Pa.

NEBRASKA STATE DENTAL SOCIETY

The fifty-fourth annual meeting of the Nebraska State Dental Society will be held at Omaha, May 16, 17, 18, 19, 1921. The meeting is to be held in the large city auditorium accommodating clinics, papers, and exhibits, and an unusual effort is being made to make it of interest. All members of the National Association are invited and will be made welcome.

H. E. KING, *Secretary*

PHILADELPHIA DENTAL COLLEGE ALUMNI SOCIETY

The annual meeting of the Alumni Society of the Philadelphia Dental College will be held on Wednesday, April 20, 1921, at 9:00 A. M., in the College building at Eighteenth and Buttonwood Streets, Philadelphia. All members of the Alumni should note the date and arrange to be present. A reunion of the class of 1916, will be held on Tuesday, April 19, 1921. "All out and as you were."

H. D. SHIELDS, *Publicity Committee*
484 Roxborough Ave., Philadelphia, Pa.

ALUMNI SOCIETY OF THE DEWEY SCHOOL OF ORTHODONTIA

The next annual meeting of this society will be held on April 25 and 26 at the Hotel Ambassador in Atlantic City. The usual high standard of the meetings of this society will be maintained. Clinics and evening sessions will be included in the program. All interested in orthodontia are cordially invited to attend these meetings.

GEORGE F. BURKE, *Secretary*
741-43 David Whitney Bldg., Detroit, Mich.

THE DENTAL SOCIETY OF THE STATE OF NEW YORK

The Dental Society of the State of New York will hold the fifty-third annual meeting at the Hotel Commodore, Forty-second Street and Lexington Avenue, New York City, May 11, 12, 13, and 14, 1921. All literary exercises, clinics, and exhibitions will be staged at the Hotel Commodore. The society extends a most cordial welcome to all ethical dentists in New York and sister-states. Make reservations early at the Hotel Commodore. Exhibitors are requested to address Dr. H. C. Bennett, Chairman of the Exhibits Committee,

576 Fifth Avenue, New York City. For further information, address

A. P. BURKHART, *Secretary*
52 Genesee St., Auburn, N. Y.

OKLAHOMA STATE DENTAL SOCIETY

The Oklahoma State Postgraduate Course will be held in Oklahoma City, March 14-19, inclusive. At this session we will have some of our instructors who have been with us in the past, Dr. Arthur E. Smith, Dr. F. Ewing Roach, of Chicago, Dr. W. T. Maves, of Minneapolis, and Dr. Dayton Dunbar Campbell, of Kansas City. These men will give instruction in their special branches. Dr. Willis Gosto, of Topeka, Kansas, will give a general practitioner's course, endeavoring to cover the entire general practice as best one can in the short period of one week. We are making a new departure in one course this year. For the past eight or nine years we have been conducting postgraduate courses and have developed some very good men. Never, until this year, have we attempted using any of our local men as instructors. We will have this year, A. L. Walters and J. M. Temples, of Tulsa, giving courses in pyorrhea, prophylaxis and root-canal work. Saturday will be used largely for clinical work. The outlook for a good meeting is very flattering.

A. E. BONNELL, *General Manager*

MISSOURI STATE DENTAL ASSOCIATION

The fifty-sixth annual meeting of the Missouri State Dental Association will be held at Springfield, Missouri, April 25, 26 and 27. The meeting will take the form of an intensive postgraduate course. Five distinct and separate courses will be given by prominent men on various subjects. More detailed information will be given at a future date.

CARLYLE POLLOCK, *Secretary*

VERMONT STATE BOARD OF DENTAL EXAMINERS

The next meeting of the Vermont Board of Dental Examiners for the examination of candidates to practice in Vermont, will be held at at State House, Montpelier, June 27, 28, 29. Candidates will present for registration and preliminaries at 10:00 A. M., Monday, June 27. To be eligible for examination a candidate must be (1) twenty-one years of age; (2) a graduate of a high school of the first class; (3) a graduate of a reputable dental college. Applications must be in the hands of the secretary not later than June 20.

For further information and application blank, address,

HARRY F. HAMILTON, *Secretary*
Newport, Vt.

AMERICAN INSTITUTE OF DENTAL TEACHERS

At the annual meeting of the American Institute of Dental Teachers, held at Indianapolis, Indiana, January 24, 25, 26, the following officers were elected for the ensuing year: President, Dr. Guy S. Millberry, University of California, San Francisco, Cal.; vice-president, Dr. A. H. Hipple, Creighton University, Omaha, Nebr.; secretary-treasurer, Dr. Abram Hoffman, 381 Linwood Ave., Buffalo, N. Y.; executive board, Dr. A. E. Webster, Royal College of Dental Surgeons, Toronto, Ont., one year; Dr. E. D. Coolidge, University of Illinois, Chicago, Ill., two years; Dr. H. E. Wheeler, College of Dental and Oral Surgery, New York City, three years.

The next meeting will be held the third week in January, 1922, at Montreal, Quebec.

CLUB OF PHYSICIAN-ANESTHETISTS

The physician-anesthetists of Chicago have organized and elected officers as follows: president, Dr. Isabella C. Herb; first vice-president, Dr. T. Edward Costain; secretary-treasurer, Dr. Frances E. Haines. The object of this society is the advancement of the science and art of anesthesia. Meetings will be held the second Monday evening of each month. Physicians, dentists, teachers, and students of allied sciences are cordially invited to attend.

FRANCES E. HAINES, *Secretary*
1618 W. Adams Street, Chicago

MICHIGAN STATE DENTAL SOCIETY

The next annual meeting of the Michigan State Dental Society will be held at the Hotel Statler, Detroit, April 11-16, 1921. William H. Elliott, 7643 E. Jefferson Ave., Detroit, Michigan, is chairman of the Program Committee. W. H. Waller, 613 Washington Arcade, Detroit, Michigan, is in charge of exhibits. W. A. Cook, 422 McKerchey Building, Detroit, Michigan, is in charge of hotel reservations.

CLAUDE S. LARNED, *Secretary*
614 Post Bldg., Battle Creek, Mich.

DETROIT DENTAL CLINIC CLUB

A school of instruction, consisting of a series of clinics and lectures on the following subjects will be opened on April 18, 1921: Prosthodontia, April 18 to April 30; Porcelain Crown, May 2 to May 14; Preventive

Dentistry, date to be announced later; Crown and Bridge, date to be announced later; Oral Surgery, date to be announced later; Gold and Porcelain Inlay, date to be announced later. Each subject will be as thoroly covered as is possible in a period of two weeks. Past clinics given by this club have only been a prelude to the manner in which these subjects will be presented at these sessions. Members of the club contribute their services. Registration fees assist in further advancement of the clinics.

As the classes are limited to twelve members, those wishing to qualify should write at once for full particulars to O. W. White, President.

E. L. GIFFEN, *Secretary*
704 Fine Arts Bldg., Detroit, Mich.

MISSISSIPPI STATE BOARD OF DENTAL EXAMINERS

The next regular annual meeting of the Mississippi State Board of Dental Examiners will be held in the Senate Chamber of the State Capitol Building at Jackson, June 21, 1921, beginning at 8:30 A. M. All applicants are required to furnish credentials of graduation from a recognized school of dentistry, certificate as to moral character, etc. Examination consists of written and practical procedure. Fee of $10 should accompany application and reach the secretary by June 10. Applicants must furnish instruments and patients for the practical work. For blanks and rules governing the examination, address,

BURT J. MARSHALL, *Secretary*
Marks, Miss.

CALIFORNIA STATE DENTAL ASSOCIATION

The next annual meeting of the California State Dental Association will be held in San Francisco, June 27 to July 2, inclusive.

FRED J. SEIFERD, *Secretary*
909 Hyde St., San Francisco, Cal.

THE NEW JERSEY STATE DENTAL SOCIETY

The annual meeting and convention of the New Jersey State Dental Society will be held on the Steel Pier, Atlantic City, New Jersey, **June 1, 2, 3, 1921. The best thought on modern dental problems will be secured for this meeting by Dr. E. C. Stillwell chairman of the Essay Committee. Dr. Charles Faupel, 484 Bergen Avenue, Jersey City, New Jersey, as chairman of the Exhibit Committee, is arranging with representative firms for an unusual display. Members of the profession will be cordially welcomed. For a list of hotels and general information, address**

F. K. HEAZELTON, *Secretary*
223 E. Hanover Street, Trenton, N. J.

AMERICAN SCHOOL HYGIENE ASSOCIATION

NOTICE OF POSTPONEMENT

The annual meeting of the American School Hygiene Association originally scheduled for February 24, 25 and 26, at Atlantic City, has been postponed to a later date.

Announcement of the time and place will be sent as soon as the new arrangements have been completed.

H. B. BURNS, *Secretary*

SOUTH DAKOTA STATE DENTAL SOCIETY

The annual meeting of the South Dakota State Dental Society will be held in the Coliseum at Sioux Falls, South Dakota, March 28 to April 2, 1921. Postgraduate instruction will be featured. A cordial invitation is extended to all members of the National Dental Association.

ERNEST W. ELMEN, *Secretary*
608 Sioux Falls Nat'l Bank Bldg.,
Sioux Falls, S. D.

KENTUCKY STATE DENTAL ASSOCIATION

The next annual meeting of the Kentucky State Dental Association will be held in Louisville, Kentucky, April 13, 14, 15, 1921, with headquarters at the Seelbach Hotel. A clinical program of unusual interest is being arranged.

Address all correspondence to

W. M. RANDALL, *Secretary*
1035 Second St., Louisville, Ky.

THE AMERICAN SOCIETY OF ORTHODONTISTS

The American Society of Orthodontists will hold its twentieth annual meeting at the Hotel Ambassador in Atlantic City, on April 27, 28, 29, and 30, 1921. A cordial invitation to attend this meeting is extended to all interested in orthodontia.

RALPH WALDRON, *Secretary*
549 High Street, Newark, N. J.

PENNSYLVANIA STATE DENTAL SOCIETY

The fifty-third annual meeting of the Pennsylvania State Dental Society will be held in the Bellevue-Stratford Hotel, Philadelphia,

May 3, 4, 5, 1921. An interesting and instructive program has been prepared. All ethical practitioners are invited to be present.

W. L. FICKES, *Secretary*
East End Trust Bldg., Pittsburgh, Pa.

XI PSI PHI FRATERNITY

The National Alumni Association of the Xi Psi Phi Fraternity will hold its annual meeting and reunion at Milwaukee, Wisconsin Hotel, August 15. Don't fail to be there.

J. EMMETT NORTHCUTT, *Secretary*

ILLINOIS STATE DENTAL SOCIETY

The fifty-seventh annual meeting of the Illinois State Dental Society will be held in Peoria, Illinois, May 10, 11, and 12, 1921. The officers of the society are as follows: president, Dr. J. P. Luthringer, 608 Jefferson Bldg., Peoria; vice-president, Dr. C. W. Coltrin, 208 N. Mason Ave., Chicago; president-elect, Dr. F. B. Noyes, People's Gas Bldg., Chicago; secretary, Dr. Arthur G. Smith, 511 Cental National Bank Bldg., Peoria; treasurer, Dr. T. L. Grisamore, 29 E. Madison St., Chicago; librarian, Dr. G. H. Henderson, 340 N. Central Ave., Chicago.

ARTHUR G. SMITH, *Secretary*

TENNESSEE STATE DENTAL ASSOCIATION

The fifty-fourth annual meeting of the Tennessee State Dental Association will be held at Nashville, May 17, 18, 19, 20, 1921.

J. J. VAUGHN, *Chairman*
Publicity Committee

MAINE DENTAL SOCIETY

The annual meeting of the Maine Dental Society will be held at Bar Harbor, Maine, June 21, 22, and 23, 1921.

B. C. GRAFFAM, *Secretary*
Portland, Me.

KANSAS DENTAL BOARD MEETING

The Kansas Board of Dental Examiners will meet at Wichita, Kansas, June 13, 1921, beginning at 7:30 P. M., for the examination of applicants for license and the transaction of any other business that may come before the board. For application blanks and any other information, write

G. F. AMBROSE, *Secretary*
111½ South Main St., Eldorado, Kan.

SOUTHWESTERN DENTAL SOCIETY

The next annual meeting of the Southwestern Dental Society will be held in El Paso, Texas, March 14, 15, 16, 1921, with headquarters at the Hotel Paso de Norta. A clinical program of unusual interest is being arranged.

R. H. GUDGER, *Secretary*
305 El Paso Bank Bldg., El Paso, Tex.

MISSISSIPPI DENTAL ASSOCIATION

The next annual meeting of the Mississippi Dental Association will be held in Jackson, April 15-19.

One of the attractive features of the meeting will be an interesting postgraduate program; in addition to this feature, the meeting will be honored by the attendance of Drs. H. E. Friesell and Otto U. King, president and secretary, respectively, of the National Dental Association.

W. F. BEAVERS, *Secretary*
Meridian, Miss.

CONNECTICUT DENTAL COMMISSION

The Dental Commissioners of Connecticut will meet at Hartford, June 23, 24, and 25, 1921, to examine applicants for license to practice dentistry, to examine dental hygienists for license to practice, and to transact any other business to come before them.

For further information address,

ROBERT H. W. STRANG, *Recorder*
886 Main St., Bridgeport, Conn.

UTAH STATE DENTAL SOCIETY

The next meeting of the Utah State Dental Society will be held the week of June 21, at Salt Lake City. The meeting will be in the form of a postgraduate course, with Drs. Thomas Hartzell, E. T. Tinker, and A. E. Smith as instructors.

FRED W. MEAKIN, *Secretary*
Judge Bldg., Salt Lake City, Utah

CONNECTICUT STATE DENTAL ASSOCIATION

The next regular meeting of the Connecticut State Dental Association will be held at Waterbury, on April 21, 22, 23, headquarters at Hotel Elton. A program of interest is being prepared.

CLESSON F. GIBBS, *Secretary*
Bridgeport, Conn.

PSI OMEGA FRATERNITY

The biennial Grand Chapter meeting of the Psi Omega Fraternity will convene Wednes-

day, August 10, at 10:00 A. M., Hotel Wisconsin, Milwaukee.

The National Alumni Chapter will meet at the same place Monday, August 15, 2:00 P. M.

Annual banquet Monday, August 15, 6:30 P. M Make reservation now with the undersigned.

Headquarters in Hotel Wisconsin will be open thruout the National Dental Association convention. Please register upon arrival.

The committee will be pleased to secure your hotel accommodations if you will address, at once,

M. M. PRINTZ, *Supreme Councillor*
25 E. Washington St., Chicago, Ill.

NORTH CAROLINA STATE BOARD OF DENTAL EXAMINERS

The next meeting of the North Carolina State Board of Dental Examiners will be held at Charlotte, beginning promptly at nine o'clock on Saturday morning, June 18, 1921.

For further information and application blanks, address

F. L. HUNT, *Secretary*
Asheville, N. C.

IDAHO STATE DENTAL EXAMINATIONS

The next examination for dentists will be held on July 12, 1921. For application blanks and full information concerning this examination, address Bureau of License, Boise, Idaho.

PAUL DAVIS, *Director*
Bureau of License

MAINE BOARD OF DENTAL EXAMINERS

The next meeting of the Maine Board of Dental Examiners will be held at the State House, Augusta, July 7, 8, and 9, 1921. Applicants must have their application and fee of $20.00, in the hands of the secretary on or before June 28.

For further information and application blanks, address

HENRY GILMAN, *Secretary*
192 State St., Portland, Me.

MASSACHUSETTS DENTAL SOCIETY

The fifty-seventh annual meeting of the Massachusetts Dental Society will be held in Boston, Massachusetts, at the Hotel Somerset, May 4, 5, and 6, 1921. A cordial invitation is extended to all members of recognized dental societies.

W. VERNON RYDER, *Secretary*
175 Newbury St., Boston, Mass.

KANSAS STATE DENTAL ASSOCIATION

The next meeting of the Kansas State Dental Association will be held in Wichita, Kansas, March 21, 22, 23, 24, 25, 26, 1921. The first two days will be for open meetings, the remainder for postgraduate work.

C. K. WEAVER, *Secretary*

NORTHERN OHIO DENTAL ASSOCIATION

The Northern Ohio Dental Association will meet in Cleveland during June 6, 7, 8. The officers are extremely fortunate to announce that the program has been completed. The most prominent men in the profession have been engaged to teach you. Make your reservation now. Watch for further notice.

IOWA STATE DENTAL BOARD

The Iowa State Board of Dental Examiners will meet for the purpose of examining candidates for a license to practice in Iowa, at Iowa City, College of Dentistry, beginning Monday, June 6, 1921, at 9:00 A. M.

For further information and application blanks, address

C. B. MILLER, *Secretary*
726 Fleming Bldg., Des Moines, Ia.

NORTH CAROLINA STATE DENTAL SOCIETY

The forty-seventh annual meeting of the North Carolina Dental Society will be held in the Selwyn Hotel, Charlotte, North Carolina, June 21, 22, 23, and 24, 1921. W. M. Robey, of Charlotte, is chairman of the Program Committee; J. S. Hoffman, of Charlotte, is chairman of the Exhibits Committee.

H. O. LINEBERGER, *Secretary*
Raleigh, N. C.

MONTANA STATE DENTAL SOCIETY

The annual meeting of the Montana State Dental Society and postgraduate course, will be held in Billings, May 16 to 21. A cordial invitation is extended to all members of the National Dental Association and its component societies.

F. W. ADAMS, *Secretary*
207 Hart-Albin Block, Billings, Mont.

ALABAMA BOARD OF DENTAL EXAMINERS

The Board of Dental examiners of Alabama will meet Monday morning, June 20, 1921, at nine o'clock A. M., at the Birmingham

Dental College, Avenue F and Twentieth Street, Birmingham, for the purpose of examining applicants who hold diplomas from reputable dental colleges, for certificate of qualification to practice dentistry in Alabama. All applications accompanied by the examination fee must be filed with the Secretary-Treasurer at least one week before the examination. For further information, application blanks, etc., address,

H. CLAY HASSELL, *Secretary-Treasurer*
616 Twenty-second Ave., Tuscaloosa, Ala.

NEW JERSEY BOARD OF REGISTRATION

The State Board of Registration and Examination in Dentistry of New Jersey will hold their regular examination in the Second Regiment Armory, Trenton, New Jersey, June 27 to July 1, 1921. License fee, $25.00; re-examination fee, $10.00.

Practical tests required: Insertion of an approximal gold filling with the approximating tooth in position, compound approximal amalgam filling, and a silicate filling; candidate must furnish his own patient. Taking of impressions, bite, selection of teeth, articulation, trial plate; candidate must furnish his own patient. Practical examination in mouth diagnosis.

Attention is directed to the following quotation from the dental law of New Jersey: "Applicant shall present to said board a certificate from the commissioner of education of this state, showing that before entering a dental college he or she had obtained an academic education consisting of a four-year course of study, or the equivalent thereof." In accordance with this law the secretary will issue application blanks only upon presentation of the required certificate from the Commissioner of Education, State House, Trenton, New Jersey.

Applications must be filed, complete, ten days before the date of the examinations. Address all communications for further particulars to

JOHN C. FORSYTH, *Secretary*
429 E. State St., Trenton, N. J.

RESOLUTIONS ADOPTED AND REPORT OF COMMITTEE REGARDING APPOINTMENT OF DENTISTS ON HOSPITAL STAFF.

RESOLUTIONS

Resolved, That in the standardization of hospitals the personnel of the staff should include a competent dentist whose duties should include consultation with the attending physician and aid in diagnosis by locating the source of focal infection in the mouth; and be it

Resolved, That such dental member of the hospital staff should insist on thoro use of the X-ray for locating diseased teeth and pyorrhea pockets and that he should be trained in the correct interpretation of dental radiographs and that the interpretation of such radiographs be made preferably by the dental member of the staff; and that such dental member should supervise the instruction to nurses in the preparation of patients' mouths for operations and in the general oral hygiene for patients; and that he take care of any dental operations; and that a dental engine and other necessary instruments and apparatus for emergency operations of all kinds be provided. Be it further

Resolved, That it is the sense of this association that the suggestions made and the policy outlined in these preambles and resolutions be adopted as the future policy of the association; and that it be earnestly requested that hospital staffs be so constituted that the fullest cooperation may be had between the physicians and dentists in the diagnosis and treatment of cases.

REPORT

The committee to formulate a definite policy for carrying out the resolution regarding the placing of dentists upon all hospital staffs submitted the following report. This report was adopted.

1. That the committee send a letter to each state dental society, accompanied by a copy of the resolutions adopted by the House of Delegates.

2. The secretary of each state dental society to transmit the resolutions and instructions to the executive council for early action These resolutions and their action to be read at the first meeting of their state society.

3. Upon favorable action of the executive council, the resolutions and instructions to be transmitted to each component society in the state.

4. The resolutions and instructions to be presented at the first meeting of the component society held thereafter. The president of each component society to appoint a committee, whose duties are to personally present the matter before the executive board and the superintendent of each hospital in its district and to present to him an exact copy of the resolutions passed by the National Dental Association.

5. The dentists for each hospital to be recommended by the component society and his appointment to be determined by his experience and ability to cooperate with the attending physician.

6. A copy of these resolutions to be sent to the American Medical Association with a recommendation that it be presented to the

House of Delegates for their consideration. A copy of these resolutions to be published in the Journal of the American Medical Association.

7. These resolutions and action taken by the committee to be published in The Journal of the National Dental Association and copies to be sent to the editors of other dental journals with the request that they be published.

8. The secretary of each state society is requested to report to the Chairman of this committee not later than thirty days previous to the annual meeting of the National Dental Association, (1) as to cooperation in progress of hospital boards, and (2) the number of appointments made, so that this committee can report in full to the House of Delegates.

Respectfully submitted,

ARTHUR E. SMITH, *Chairman*, Chicago, Ill.
WM. H. G. LOGAN, Chicago, Ill.
C. EDMUND KELLS, New Orleans, La.
C. R. LAWRENCE, Enid, Okla.

DENTAL CORPS ORDERS FROM WAR DEPARTMENT

ARMY DENTAL CORPS

The following named officers have been designated to relieve the officers who are returning to this country from foreign service by the expiration of the two-year tour of duty abroad. Major F. H. Bockoven, on duty at Fort Sill, and Captain L. W. Maly, on duty at Fort Huachuca, Ariz., to the Philippines; Lieutenant H. T. Ostrum, on duty at Camp Pike, and Lieutenant E. G. Gebhardt, on duty at Camp Grant, to Hawaii.

DENTAL CORPS

Major Charles DeW. Deyton, First Lieutenant Arthur C. Foard report by telegraph to commanding general 8th corps area for assignment to duty and station.

Captain Robert E. Motley from duty at attending surgeon's office, Washington, and report by telegraph to commanding general 7th corps area for duty.

First Lieutenant Roy A. Stout from duty at Fort Oglethorpe, Ga., to 8th corps area for duty.

First Lieutenant Everett H. Ruggles from duties at Camp Dix, N. J., to New York City and about March 10 to Panama Canal Department for duty.

Resignation by First Lieutenant Stanley R. Rayman accepted for the good of the service.

DENTAL RESERVE CORPS

Captain William P. Katz to active duty at Denver, Colo., Fitzsimmons General Hospital.

First Lieutenant Albert C. Dumke to active duty in 2d corps area.

—*Army and Navy Register*, January 29, 1921.

DENTAL CORPS

Major Frederick H. Bockoven and Captain Lewis W. Maly, to San Francisco and about April 5 to Philippine Department for duty.

Captain John C. Campbell, upon arrival in United States to ninth corps area for duty.

First Lieutenants Earl G. Gebhardt and Harry T. Ostrum, to San Francisco and about February 25 to Hawaiian Department for duty.

DENTAL RESERVE CORPS

Captain William P. Katz, to active duty at Fitzsimmons General Hospital, Denver, Colo.

Captains William B. Williams and Harry V. Talbert, proceed home and stand relieved from active duty.

—*Army and Navy Register*, February 5, 1921.

DENTAL CORPS

The following, upon arrival in the United States, will report by telegraph to commanding general of the corps area specified for assignment to duty and station: Captains Benjamin H. Dean, 8th corps area; LeRoy P. Hartley, 5th corps area; James H. Keith, 1st corps area.

Resignation by First Lieutenant William J. Crydermann accepted.

DENTAL RESERVE CORPS

Captain Isaac H. Whyte to duty in 2d corps area.

—*Army and Navy Register*, February 12, 1921.

APPOINTMENTS IN DENTAL DEPARTMENT

The following temporary (T) and reserve (R) officers have been found qualified for permanent commissions in the dental corps, with the rank of lieutenant: Harold I. Cragin (R), Frank V. Davis (T), Nicholas S. Duggan (T), John S. George (R), Charles P. Holland (R), Leonard L. Martin (R), Henry Muenzer (R), Elmer C. O'Connell (R), Rolland W. Quesinberry (T), Walton C. Carroll (T), Clarence A. Chandler (T), Larry Dupuy (R), Edward J. Fitzgerald (T), Clifford E. Kelly (R), Harrison J. LaSalle (R), Edmund Laughlin (T), Henry C. Lowry (R), John L. McCarthy (R), Ralph P. Morse (R), Chas. H. Morris (R), William F. Murdy (T), Edward J. Noonan (T), George L. Reilly (T), Carl E. Reynolds (T), William J. Rogers (T), Charles O. Sandstrom (R), James J. Spring (T), Albion C. Tollinger (T), John A. Waters (T), and Chester H. Webber (T).